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**FISHERY PROGRESS REPORT SERIES NO. 05-1**  
**RAPID RIVER AND POND IN THE RIVER FISHERY INVESTIGATIONS**

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**JOBS F-101, F-104, AND F-201**  
**PROGRESS REPORT NO. 2**  
**RAPID RIVER AND POND IN THE RIVER FISHERY INVESTIGATIONS**

**SUMMARY**

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The Rapid River in Oxford County has been long noted for its outstanding fishery for native brook trout. Landlocked salmon are also present and provide an important ancillary fishery. Salmon are not native to this drainage, having been introduced during the late 19<sup>th</sup> century. Pond in the River (512 acres) divides the Rapid River into two distinct segments and also supports populations of brook trout and salmon, but their presence is only transitory; adult brook trout utilize it as a summer temperature refuge and for over-wintering.

The Rapid River and Pond in the River drain to 7,850-acre Umbagog Lake, which in turn outlets to the Androscoggin River in New Hampshire. Although water temperatures are warm during the summer months, Umbagog Lake provides important over-wintering habitat and is utilized by Rapid River brook trout during the spring and early-summer periods. Smallmouth bass were illegally introduced into Umbagog Lake during the mid 1980s and have since migrated to other connecting waters, including the Rapid River and Pond in the River. Smallmouth bass are serious predators on and competitors with brook trout.

Since 1994, the Maine Department of Inland Fisheries and Wildlife (MDIFW) and FPLE Energy have conducted a variety of fishery studies on the Rapid River and Pond in the River. The purpose of this work was to 1) monitor the response of the river's sport fisheries to restrictive fishing regulations imposed in 1996; 2) evaluate the effects of altered river flows on brook trout and salmon populations and the fisheries they support; 3) evaluate impacts from smallmouth bass by assessing habitat use of adult and juvenile brook trout, salmon, and smallmouth bass; 4) and describe the genetic characteristics of Rapid River brook trout. These studies provided important information on sport fisheries, population size and age structure of principal predator fish, and habitat characteristics and utilization. This work provided justification for a variety of fishing regulation changes designed to enhance brook trout production by providing them additional protection and reducing competition from salmon, and identified possible strategies for mitigating the negative effects that smallmouth bass are likely to have on brook trout production.

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**ABSTRACT**

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The Rapid River and Pond in the River support important fisheries for brook trout (*Salvelinus fontinalis*) and landlocked salmon (*Salmo salar*). Smallmouth bass (*Micropterus dolomieu*) have recently colonized the Rapid River and Pond in the River from an unauthorized introduction in downstream Umbagog Lake. A variety of fishery studies have been completed to monitor the response of the river's sport fisheries to restrictive fishing regulations, altered river regimes, and the presence smallmouth bass. Radio telemetry techniques were used to assess habitat use of adult and juvenile brook trout, salmon, and smallmouth bass, and the genetic characteristics of Rapid River brook trout were described.

Clerk creel surveys showed annual angler use on the Rapid River in 2003 and 2004 was  $5,435 \pm 1,298$  and  $5,101 \pm 1,366$  trips, respectively, and suggested a trend of declining use. Catch rates for brook trout  $\geq 305$  mm showed a declining trend (0.152, 0.130, and 0.086 fish/hr from 2002 to 2004, respectively), while catch rates for legal-size ( $\geq 356$  mm) salmon during the same period were variable but exhibited no apparent trend. Ratios of brook trout  $\leq 305$  mm declined steadily after 1998. Catch rates for sublegal salmon ( $\leq 356$  mm) showed no clear trend. Smallmouth bass catch/hr increased steadily from 0.009 in 1999 to 0.065 in 2004. Catch statistics provided by volunteers from 1998 to 2004 were largely consistent with those from the clerk surveys. Average size of brook trout and salmon reported by volunteers generally improved since 1998. Average smallmouth bass sizes reported by volunteers ranged from about 140 to 200 mm.

Telemetry studies showed adult Rapid River brook trout ranged freely during the late winter-early summer period, utilized Pond in the River for summer thermal refuge, concentrated in a single river reach prior to and during spawning, and then over-wintered in Pond in the River, Umbagog Lake, and at one site in the Rapid River. Adult salmon utilized the habitat in similar ways, but smallmouth bass were largely sedentary.

Trapnet samples indicated an abundant forage base for smallmouth bass, including crayfish.

Emergent brook trout fry were concentrated at three sites adjacent to major spawning areas. Peak salmon emergence occurred later than for trout but there was overlap. Salmon fry and juvenile smallmouth bass were closely associated with brook trout fry at all sites. Thermal refuge sites for brook trout fry were identified in the Rapid River. Juvenile salmon and smallmouth bass occupied these same sites, particularly during the late-summer period.

Diving surveys documented the use of Pond in the River by spawning smallmouth bass, verified brook trout spawning sites, and provided evidence that salmon competed with brook trout for limited spawning gravel.

Food habits data confirmed that smallmouth bass are predators on young brook trout and salmon, and they provided strong evidence that food competition occurred at this life stage.

Older age brook trout (age IV+ and older) comprised 29% of samples. Brook trout growth rates and body condition remained excellent despite recent increases in numbers of smallmouth bass. Wild and hatchery-reared salmon comprised 86% and 14% of the catch, respectively. Wild salmon continued to exhibit slow growth rates typical of river-resident fish.

Genetic analysis indicated that Rapid River brook trout were distinct from, but closely related to, two nearby populations. The degree of divergence of Rapid River brook trout from the Lower Magalloway and Kennebago Lake populations was small, and some level of gene flow between them probably occurs.

This work supported a variety of fishing regulation changes designed to enhance brook trout production by providing them additional protection and reducing competition from salmon, and identified strategies for mitigating the negative effects of smallmouth bass.

KEY WORDS: BKT, LLS, SMB, ANGLER SURVEY, REGULATIONS, AGE & GROWTH, COMPETITION, FLOW REGIMEN, FOOD HABITS, GENETICS, MOVEMENT, SCUBA, SPAWNING MIGRATION, TELEMETRY

## INTRODUCTION AND STUDY AREA

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The Rapid River in Oxford County has long been noted for its outstanding brook trout (*Salvelinus fontinalis*) population. These fish, which are native to the upper Androscoggin River drainage, are highly valued both ecologically (Fraser et al. 2004) and economically. Brook trout in the Rapid River are sustained entirely by natural reproduction and support a popular, heavily utilized sport fishery of regional and statewide significance.

Landlocked salmon (*Salmo salar*) are also present and provide an important ancillary sport fishery. Salmon were introduced into this drainage during the late 19<sup>th</sup> century and became naturalized in the Rapid River. They are presently abundant and relatively slow growing (Boucher 2002). The salmon population is supported by natural reproduction, although hatchery stocks contribute small numbers to the fishery as emigrants from upstream lakes.

Pond in the River (512 acres) divides the Rapid River into two distinct segments (Figure 1). This water supports populations of brook trout and salmon, but their presence is transitory. Nevertheless, Pond in the River is an important habitat feature in the Rapid River drainage because adult brook trout utilize it as a summer temperature refuge and for over-wintering. Salmon use Pond in the River in similar ways but to a lesser extent (FPL Energy 2004).

Flows in the Rapid River are controlled at Middle Dam, located on the outlet of the Richardson Lakes. Middle Dam is one of several large dams controlling water levels on lakes in the upper Androscoggin River drainage. Currently owned by FPL Energy (FPLE), their primary function is to provide guaranteed minimum flows to a variety of downstream industrial and municipal interests. Middle Dam was recently re-licensed by the Federal Energy Regulatory Commission. Consequently, new summer and winter minimum flows were established for the Rapid River beginning in 2000. Water releases from Middle Dam have only a minor effect on water levels in Pond in the River.

The Rapid River and Pond in the River drain to 7,850-acre Umbagog Lake, which outlets to the Androscoggin River in New Hampshire. Umbagog Lake is largely homothermous and supports several warmwater fish species, so it provides only marginal habitat for cold water fishes. It does, however, provide important over-wintering habitat for Rapid River brook trout (FPLE 2004). The lake is also utilized by Rapid River brook trout during the spring and early-summer periods, presumably for foraging. A USFWS Wildlife Refuge encompasses a portion of its shoreline. The Refuge's activities are directed primarily at loon and waterfowl production. Maintaining stable water levels during the loon nesting period (June-July) is therefore an important element of the Refuge's wildlife management mission.

During the 1980's, smallmouth bass (*Micropterus dolomieu*) were illegally introduced into Umbagog Lake. They became well established there and have since migrated to other connecting waters, including the Rapid River and Pond in the River (Boucher 2002). Middle Dam restricts their natural migration into other waters in the Rangeley chain of lakes. A popular and economically important sport fishery for smallmouth bass has developed in Umbagog Lake, which is largely in New Hampshire (D. Emerson, NH Fish and Game Dept., personal communication).

The Rapid River and Pond in the River provide excellent habitat for all life stages of smallmouth bass and, as expected, their population numbers have increased since 2000 (Boucher 2002). Smallmouth bass are serious predators on and competitors with brook trout. Their negative impacts on brook trout production may be particularly severe during the next several years because smallmouth bass production is expected to be initially very high in these new, productive habitats. Landlocked salmon are more tolerant of smallmouth bass and this population is expected to persist.

Since 1994, the Maine Department of Inland Fisheries and Wildlife (MDIFW) and FPLE have conducted a variety of fishery studies on the Rapid River and Pond in the River. The purpose of this work has been to 1) monitor the response of the river's sport fisheries to restrictive fishing regulations imposed in 1996; 2) evaluate the effects of altered river flows on brook trout and salmon populations and the fisheries they support; 3) evaluate impacts from smallmouth bass by assessing habitat use by adult and juvenile brook trout, salmon, and smallmouth bass; 4) describe the genetic characteristics of Rapid River brook trout.

These studies have provided important information on sport fisheries, population size and age structure of principal predator fish, and habitat characteristics and utilization. This work has led to a variety of fishing regulation changes (effective in 2004) designed to enhance brook trout production by providing them additional protection and reducing competition from salmon. We have also identified possible strategies for mitigating the negative effects smallmouth bass are likely to have on brook trout production.

Much of the work conducted prior to 2003 has been summarized in Boucher (1995, 2000, and 2002) and FPLE (2004). The purpose of this paper is to report findings of work completed in 2003 and 2004, and to summarize much of the historic data collected from the Rapid River and Pond in the River. These data will provide background information useful for assessing new fishing regulations, flow effects, and smallmouth bass impacts.

## METHODS

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### *Creel surveys (fishery assessments)*

Clerk creel surveys, funded and staffed by FPLE as a condition of FERC re-licensing, were conducted in 2003 and 2004 to monitor angler use, catch, and harvest subsequent to changes fishing regulations and flow regime, and to monitor fishery impacts from smallmouth bass. The surveys and angler counts were conducted from early May to September 30 during both years (Table 1). The river was divided into two sections (Figure 2) based on the intensity of angler use observed during previous surveys. The upper section extended from Middle Dam and downstream for 1.3 miles to the lower end of Long Pool, excluding Pond in the River. The lower section, about 1.9 miles in length, extended from Long Pool to Umbagog Lake.

The surveys were of a stratified random design with one weekend day and one weekday sampled each week. Each survey day was divided into three time periods of equal length (8AM-12PM; 12PM-4PM; and 4PM-8PM). Time periods were sampled randomly within each survey day with approximately equal coverage given to each period throughout the survey. During each sampling event, clerks made instantaneous

counts of anglers fishing each section, excluding those fishing Pond in the River. Standard clerk interviews were conducted at popular fishing spots to collect catch and harvest data. Total fishing effort for each section and the entire reach was estimated from formulae described by Pollack et al. (1994) for a roving survey.

Data from the 2003 and 2004 surveys are compared with similar surveys conducted in 1994, 1998, 1999, and 2002, and with voluntary angler data collected annually since 1998.

### ***Telemetry studies***

FPLE staff utilized radio telemetry techniques to assess habitat use, including spawning locations, and seasonal movements of adult brook trout, salmon, and smallmouth bass. Methodology details and study results are reported in a separate document (FPLE 2004). A brief description of the technique and a summary of results are included in this report.

In 2002, adult brook trout, salmon, and smallmouth bass were captured by angling from several locations in the Rapid River. In total, twenty-four brook trout, eight salmon, and one smallmouth bass captured from mid-June and early July were surgically implanted with radio transmitters. Transmitters were non-programmable tags manufactured by Advanced Telemetry Systems, Inc. (ATS). Tags were capable of transmitting signals 24 hours/day and had a battery life of 141 to 289 days. Radio transmissions were received by an ATS Model R2000 receiver and a Lotek Yagi directional antennae. Tracking events from the ground, boat, and small aircraft were conducted on 28 dates during the period from June 25, 2002 to May 31, 2003. Tracking events were generally spaced two weeks apart, except during the fall spawning period when sampling occurred weekly (FPLE 2004).

Telemetry studies were continued in 2003 and 2004, with tagging efforts focused on adult salmon and smallmouth bass. Fish collections for tagging were made with small trapnets fished in Pond in the River in May (see below), and in the Rapid River by angling and backpack electrofishing gear in mid-June. A total of 18 salmon and 12 smallmouth bass were radio-tagged as described above. Tags, receiver gear, and tracking technique, timing, and frequency were similar to the 2002-2003 study.

### ***Pond in the River trapnetting***

Objectives of this work were to collect smallmouth bass and salmon for the telemetry study, to confirm species composition and relative abundance of the lake's fish assemblage, and to obtain age-specific size data on smallmouth bass and salmonids.

Two Oneida-style trapnets were fished in Pond in the River from May 6 to May 23, 2003. The nets were comprised of 1/2-in mesh (square measure) with cod ends measuring five feet square. Nets were fished from shore attached to 1/2-in square mesh leads from 50 to 60 ft long. They were deployed at three locations: on the north shore just south of the inlet from the Rapid River; on a rocky point near the deep cove at the pond's southernmost end; and on the north shore about 1/3-mile above the remnants of Lower Dam. Total fishing effort (both nets combined) was 719 hours (30 days). All smallmouth bass, salmon, and brook trout captured were anesthetized with a 5% clove oil solution, measured, weighed, and samples of scales were obtained for age determination. All other species were identified and enumerated.

### ***Salmonid fry surveys***

Work in 2003 and 2004 focused on identifying brook trout and salmon fry emergence times and sites, locating thermal refuge areas, and on conducting preliminary assessments of interactions of age 0 trout with young salmon and smallmouth bass in the “emergent zones” and in thermal refuges. Backpack electrofishers were used to collect fry on eight dates from May 29 to September 30, 2003, and on six dates from May 26 to September 22, 2004. Twelve sites from Middle Dam downstream to within about 0.4 miles above Umbagog Lake were sampled on most, but not all dates, depending on the availability of staff and time (Figures 3 and 4). Brook trout and salmon fry were enumerated and measured for total length. All smallmouth bass were euthanized prior to collection of stomach contents and scale samples. Other fish species and crayfish were identified and their presence recorded.

In mid-July 2003, five sites in Pond in the River were examined by boat and backpack electrofishers. Potential cool-water refuge sites for young brook trout were selected by examining topographical features of the surrounding landscape as indicators of groundwater inputs through seepage areas. With the exception of one small intermittent stream entering the lake’s north shore, tributaries to Pond in the River are absent.

### ***Scuba observations***

In mid-June of 2003, scuba divers from MDIFW, FPLE, and Cornell University examined about 1.8 miles of near-shore habitat in Pond in the River. Portions of the southeastern and northwestern shorelines were surveyed, as well the shorelines of two large islands located at the lake’s western end. The objective of this work was to determine the current distribution of smallmouth bass in the Rapid River drainage. Divers on towed planing boards enumerated smallmouth bass and classified their size in four broad length categories (<7, 7-11, 11-15, and >15 inches). Smallmouth bass nests were enumerated and an attempt was made to determine status of nesting (e.g. attendant males, presence of eggs or fry, fry stage, etc.). This work was repeated on June 10 and 11, 2004, except that two additional transects were included on the eastern and southwestern shorelines.

On five dates from early October to early November in 2002, 2003 and 2004, FPLE and MDIFW divers examined several areas in the vicinity of Lower Dam and Long Pool (Figure 3). The purpose of this effort was to further document use of these sites by spawning brook trout and salmon.

### ***Smallmouth bass food habits***

Smallmouth bass food habits data were collected from the Rapid River, Pond in the River, and Umbagog Lake. The purpose of this work was to provide information on the nature and extent of predation and competition with brook trout, and to document prey selection by smallmouth bass in recently colonized environments. Samples were obtained using a variety of sampling gear, including backpack electrofishers, angling, and trapnets. Except for a single sampling event in Pond in the River in mid-August, smallmouth bass stomachs samples collected in 2003 were taken in conjunction efforts to collect brook trout and salmon samples. Sampling in 2004 occurred in conjunction with a

fishing derby on Pond in the River on June 11, by angling from Pond in the River in mid-September and Umbagog Lake in late June, and incidentally with salmonid fry collections in the Rapid River throughout the open water season. Frozen or preserved specimens were dissected and stomach contents examined under a dissecting microscope. When feasible, fish items were identified to the species level, insects to order, and other items to the lowest taxonomic level possible.

### ***River temperature regime***

FPLE staff collected water temperature data at four sites on the Rapid River during the period March 2002 to September 2003. Sites were at Middle Dam tailrace, Lower Dam, Smooth Ledge Pool (1.2 miles below Lower Dam), and Cedar Stump Pool (1.9 miles below Lower Dam). HOBO<sup>®</sup> loggers (Onset Corp.) collected continuous temperature data at 2-hour intervals throughout the period.

### ***Fish population age and size structure***

Size and growth characteristics of brook trout, salmon, and smallmouth bass were estimated for fish collected during all phases of our work in 2003 and 2004. The majority was captured by angling or by backpack electrofishing. All salmonid fish, except fry and older juveniles captured by electrofishing, were anesthetized prior to obtaining length, weight, and scale samples. Smallmouth bass from the Rapid River, Pond in the River, and Umbagog Lake were euthanized prior to obtaining size information, sex and maturity status, and scale samples. Saggital otoliths were collected from subsamples of smallmouth bass to improve the precision of age estimates derived from the scale method (Boucher 1998). A detailed discussion of bass age and size structure, age and size at maturity, and stomach analysis will be provided in a separate report.

The 2003 and 2004 samples were combined with those obtained from previous surveys, including the initial netting survey of Pond in the River in 1961, to describe growth and age structure prior to ongoing or impending changes in fishing regulations and flow regime, as well as to document conditions prior to or during the recent colonization of smallmouth bass.

### ***Brook trout genetics study***

Fin tissue samples from 31 brook trout were obtained in mid-September and early October 2003 for genetic analysis. September samples included 15 fry collected by backpack electrofishing at several sites below Lower Dam. October samples (16) were adults collected by angling from the area just upstream and downstream of Lower Dam. Tissue samples were preserved in a 95% ethanol solution and analyzed by geneticists at Laval University in Quebec, Canada.

## **RESULTS AND DISCUSSION**

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### ***Creel surveys (fishery assessments)***

Angler use on the Rapid River in 2003 and 2004 was estimated to be 5,435 and 5,101 trips, respectively (Table 2). This level of use was significantly lower ( $p < 0.002$ ) than that observed in 1999, but not different than use measured in either 1994, 1998, or

2002 ( $p>0.05$ ). Data from 2002 and 2004 do suggest a trend of declining use, however. The recent development of excellent salmonid fisheries in nearby, more accessible rivers, such as the Androscoggin River, may be drawing anglers away from the Rapid River. Nonetheless, current angler use of the Rapid River remains among the highest observed on Maine rivers supporting salmonid fisheries (Table 3).

The fishery continued to be focused on the upper 1.3-mile reach between Middle Dam and Long Pool (Table 2). In 2003 and 2004, only about 6% of the total use occurred in the 1.9-mile reach from Long Pool to Umbagog Lake, which is more difficult to access (Figure 2).

Data from clerk creel surveys, summarized in Table 4, show that the Rapid River continued to provide attractive fisheries for brook trout and salmon. In 2003 and 2004, catch rates (catch/hour) for legal-size fish of both species were within or near the range observed during all other years surveyed. However, catch rates for brook trout  $\geq 12$  in have declined since 2002 (0.152, 0.130, and 0.086 fish/hr from 2002 to 2004, respectively). The catch rate for legal-size salmon ( $\geq 14$  in) during this same period varied but was more stable than for trout.

Clerk data showed catch rates of brook trout  $\leq 12$  in declined steadily after 1998 (Table 4). This statistic provides an indirect measure of recruitment when growth rates are stable. Assuming conditions for growth remained relatively stable during this period, then the data suggest that recruitment of young brook trout has diminished. Catch rates for sublegal salmon ( $\leq 14$  in prior to 2004) were variable during much of this same period and showed no clear upward or downward trend.

Smallmouth bass numbers, as indicated by catch statistics, have increased dramatically in the Rapid River. Anglers surveyed by clerks reported catching 68 smallmouth bass in 2003 and 135 in 2004; 25% and 5% of these were released in 2003 and 2004, respectively (Table 4). Catch/hr increased steadily from 0.009 in 1999 to 0.065 in 2004.

Catch statistics provided by volunteers (Table 5) from 1998 to 2004 were largely consistent with those from the clerk surveys. Catch rates (catch/hour) for brook trout  $\geq 12$  in declined slightly after 2002, and ratios of  $<12$  in-brook trout in the catch declined, particularly after 2001. Catch/hour for legal-size salmon was highly variable, and smallmouth bass numbers and catch rates increased dramatically. Volunteers reported declining catch rates for sublegal salmon after 2001, which was inconsistent with clerk data for the same period (Table 4). Average size of brook trout and salmon reported by volunteers (Table 5) generally improved since 1998. Average smallmouth bass sizes reported by volunteers have ranged from 5.5 to 7.8 in since 2001, suggesting this newly established riverine population was composed primarily of young fish.

In summary, the Rapid River continued to provide attractive sport fisheries for salmonids in 2003 and 2004, evidenced by high angler use, favorable angler success rates, and desirable size quality of brook trout. As noted in previous management summaries (Boucher 2000 and 2002), the river's brook trout population responded favorably to a catch and release rule imposed in 1996 and the closure of a portion of Umbagog Lake to winter fishing – ratios of large ( $>16$  in), older brook trout increased and recruitment appeared to improve. However, creel survey data collected since 2002 suggest that conditions may have deteriorated for recruitment and survival of brook trout, and perhaps to a lesser degree for salmon.

Our observations of declining catch rates for all sizes of brook trout may be within the range of natural variability, but it seems more probable that brook trout production was affected by rapidly changing biological and habitat conditions. For example, since 2001 we've received many anecdotal reports of cannibalism of young brook trout. These reports were commensurate with increasing numbers of large adult trout, a consequence of the catch and release rule imposed in 1996 (Boucher 2002).

Also coincident with declining trout catch rates was the colonization and vigorous expansion of smallmouth bass in the Rapid River system beginning around 1998. Smallmouth bass are known to be severe competitors with and predators on salmonid fishes. Habitat use observations made in the Rapid River in 2003 and 2004 indicated young smallmouth bass occupied critical brook trout nursery areas, particularly during the post-emergence period. Moreover, smallmouth bass food habits data collected in 2003 and 2004 strongly suggested competition with young trout for food resources, and we have documented predation on brook trout by young smallmouth bass (discussed in a subsequent section of this report).

Altered flow regimes beginning in January 2000 may have been a factor as well. Minimum flows in the Rapid River were increased from 100 cubic feet per second (cfs) to 372 cfs during the spring refill period for upstream Richardson Lake, as required in the Federal Energy Regulatory Commission (FERC) licensing agreement. The refill period generally occurs from mid March to early June and coincides with the emergent and early fry period for both brook trout and salmon. Flow/habitat suitability studies (Normandeau 1988) determined that the new flow regime was generally suitable for brook trout juveniles, but may have provided somewhat higher suitability for young landlocked salmon. Smallmouth bass habitat suitability was not determined. Impacts of the minimum flow changes on brook trout recruitment were probably minimal, however, because refill flows were actually reduced from 372 cfs to 100 or 200 cfs in two of the four years (2002 and 2003) that the new flow regime was to be in effect due to severe drought conditions. Also, overall habitat suitability and availability, as well as river channel properties, for brook trout fry are similar across a broad range of potential minimum flows (D. Nieman, Normandeau Associates, personal communication). Nevertheless, a reassessment of flow regimes in the Rapid River is recommended to assure that habitat for all life stages of brook trout is maximized, and habitat for smallmouth bass and salmon is minimized.

#### ***Telemetry studies (seasonal movements/habitat use studies)***

A detailed discussion of radio telemetry studies is provided in a separate report (FPLE 2004). A general summary and discussion of key findings is presented here (Figure 3 and Table 6).

Significant numbers of tagged brook trout moved freely and frequently throughout the entire river, presumably on feeding forays, during the mid-June to mid-July 2002. From mid-July through early September 2002, most tagged brook trout remained confined to PIR, apparently to seek thermal refuge. Historic gillnet samples and recent scuba surveys confirm the strong reliance of adult brook trout on Pond in the River for thermal relief during the warmest months of the open water season.

Pre-spawning movements were apparent by late September 2002, with many tagged brook trout locating to areas below Lower Dam (Wing Dam and Long Pool sites), and in the vicinity of the inlet to Pond in the River (Wingate site). During peak spawning

time (mid-October), major concentrations of tagged brook trout and other trout occurred between Lower Dam and Long Pool, with smaller numbers observed near the inlet to Pond in the River (Wingate site).

Post-spawning dispersal was relatively rapid from spawning locations to Pond in the River (majority) and Umbagog Lake, where most over-wintered. A substantial number of tagged brook trout over-wintered in the Rapid River itself (Smooth Ledge site). Movements of tagged brook trout from over-wintering locales to the Rapid River were observed by late March 2003, and during April and May 2003 tagged trout again ranged freely throughout the Rapid River system (Table 6).

Radio telemetry data clearly showed Pond in the River to be a critical habitat feature supporting Rapid River brook trout by providing temperature refuge during the warmest summer months, as well as providing important over-wintering habitat. Telemetry data also indicated that significant movements of adult trout to the area between Lower Dam and Long Pool occurred by mid-September. These fish maintained their position in this reach through the remainder of the fishing season (September 30) and into late October. This information supported fishing regulation changes designed to provide additional protection to these biologically important fish. Beginning in 2004, a portion of Pond in the River was closed to all fishing during July and August, and the Rapid River between Lower Dam and Long Pool was closed to fishing after September 15. These new fishing rules were intended to eliminate potential mortalities associated with hooking while adult brook trout are highly concentrated and in stressed condition.

Telemetry studies in 2003 and 2004 focused on salmon and smallmouth bass. Adult salmon moved throughout the entire Rapid River drainage, including Umbagog Lake, during the summer months (FPLE 2004). In June 2003, 75% of the tagged salmon observations were from several locations in the Rapid River, 17% were from Pond in the River, and 8% were from Umbagog Lake. During July, 56% of tagged salmon were located in Pond in the River, 33% were in Umbagog Lake, and the balance remained in the Rapid River. Several tagged salmon moved from Umbagog Lake to the Rapid River during August, but most remained in Pond in the River. Several study fish moved into known salmon spawning areas between late September and early November. There was apparently heavy post-spawning mortality of radio-tagged salmon, so over-wintering habitat was not located. Data from three radio-tagged salmon from a smaller study conducted in 2002 suggested salmon over-winter in Pond in the River, and to a lesser degree in Umbagog Lake.

Radio-tagged smallmouth bass showed little movement from their tagging locations in 2003. A single adult smallmouth bass tagged on June 17 near Long Pool, located about 0.5 mile below Lower Dam (Figure 3), moved upstream to Pond in the River by late July. This fish was observed guarding a nest on several occasions from mid-June to early July prior to migrating to Pond in the River (FPLE 2004). No significant movements of smallmouth bass were observed during the succeeding fall and winter months.

### ***Pond in the River trapnetting***

Trapnet captures are summarized in Table 7. White suckers (*Catostomus commersoni*) dominated the early spring fish assemblage in Pond in the River, comprising over 70% of the total catch. Fallfish (*Semotilus corporalis*) and five other

minnow species were also abundant (25% of the catch). A total of 16 brook trout and salmon was captured, comprising 1% of captures. Seven smallmouth bass were sampled (0.7% of the catch); all were captured after water temperatures warmed to 60°F.

Trapnet samples indicated an abundant forage base for smallmouth bass, including crayfish.

### ***Salmonid fry surveys***

Work in 2003 and 2004 focused on identifying brook trout and salmon fry emergence times and sites, locating thermal refuge areas, and conducting preliminary assessments of interactions of age 0 trout with young salmon and smallmouth bass in the “emergent zones” and in thermal refuges.

Emergent brook trout fry were observed at 9 of 10 sites sampled from late May through mid-June in 2003 (Table 8). Brook trout fry appeared to be concentrated below Lower Dam adjacent to a major spawning site, and at the Wing Dam and Long Pool sites (Figure 4). Trout fry abundance generally declined at the lower river sites. Peak salmon emergence generally occurred at later dates than for trout, but there was some overlap. Post-emergent salmon fry were closely associated with brook trout fry at all sites, except the Middle Dam tailrace and Devil’s Hopyard. Fry of both species occupied areas of quiescent flow in shallow channel margins (<1 ft deep).

Thermal refuge sites were located at Wing Dam, Sugar Shack, Long Pool, and Cold Spring Pool in 2003 (Figure 4). Additional thermal refuges were located in 2004 between Middle Dam and Pond in the River (Chub Pool sites), between Lower Dam and Sugar Shack, at Long Pool (south shoreline), and below Smooth Ledge (south shoreline). Cooling flows arose from small surface-water seepages, with the exception of the Cold Spring Pool site, which appeared to provide cool water directly from groundwater., Brook trout fry were collected at most of these sites as river temperatures reached and exceeded 68°F in 2003 and 2004. However, the largest concentrations during the mid to late summer months were clearly associated with the Chub Pool, Wing Dam, Sugar Shack, and Long Pool sites. Brook trout older than age 0 were rarely present at these thermal refuge sites. Only 5 older-age trout were captured during 15 sampling events in 2003 and 2004. This suggests either that the abundance of older brook trout juveniles was very low, or that they utilized alternative sites -perhaps the large, deep pools- during the warmest periods.

Several brook trout fry were collected in Pond in the River near the mouth of a small brook located on the north shore in late July 2003 (Figure 4). No other sources of cooler water were located, indicating that Pond in the River does not provide important summer habitat for juvenile brook trout.

Salmon fry occupied similar habitat as brook trout fry during much of the open water season in the Rapid River, but they were most closely associated with trout during the post-emergent period. The two species segregated somewhat during the warmest months when brook trout sought cooler flows at the refuge sites. Older salmon fry tolerated elevated river temperatures for much of the summer period, and they utilized more of the river channel (e.g. higher flows) than trout. However, salmon fry were frequently observed in thermal refuges previously occupied by brook trout fry during the late-summer period. This was particularly evident at the Lower Dam (downstream site), Wing Dam, Forest Lodge, and Sugar Shack sites (Table 8). It was not possible to

determine if salmon fry displaced young brook trout that were utilizing these areas, or if trout fry normally sought alternative sites during the late-summer period.

Smallmouth bass showed a similar pattern of occupying important brook trout fry habitat during the post-emergent and late-summer periods. Smallmouth bass juveniles (80-120 mm) were present at six of nine sites occupied by trout fry from late May to mid-June 2003 (Table 8). Smallmouth bass predation on brook trout and salmon fry was documented during this period. Smallmouth bass and brook trout fry interactions probably lessened during the mid summer period as trout sought cool water refuge. However, by late summer smallmouth bass again occupied habitat previously occupied by brook trout fry at the Wing Dam, Sugar Shack, and Long Pool sites, among others (Table 8).

Several Cyprinid species, suckers, slimy sculpins (*Cottus cognatus*), and crayfish (*Orconectes* spp) were commonly associated with salmonid fry in Rapid River nursery areas (Table 8). Lake chub (*Couesius plumbeus*), blacknose dace (*Rhinichthys atratulus*), longnose dace (*Rhinichthys cataractae*), and fallfish were generally the most abundant associates.

A complete summary of observations made during the 2003 fry habitat surveys is provided in Appendix 1.

### ***Scuba observations***

On June 17, 2003 three divers examined approximately 1.9 miles of the northwest and southwest shorelines, and the perimeter of the two largest islands in Pond in the River (Figure 4). Surface water temperature was 62.6°F. A total of 36 smallmouth bass was observed and distributed in size as follows: <7 in (n=28), 7-11 in (n=6), and 11-15 in (n=2). About 20 smallmouth bass nests were observed. The largest concentrations were located in the deep cove near the lake's southern shore and adjacent to the two islands. Most nests appeared to have been recently constructed. None was tended by male smallmouth bass, none appeared to have eggs, and no black fry were observed. Divers concluded that smallmouth bass nesting had only recently been initiated. Several nests were somewhat deeper (3-6 ft) than normally observed for this species in Maine. Each diver noted the presence of high quality habitat for all smallmouth bass life stages.

These same transects and two additional transects were surveyed by two divers on June 10 and 11, 2004 when surface temperature was 60°F. Six smallmouth bass were observed, all exceeding about 11 inches in size. Divers observed 17 smallmouth bass nests concentrated on the eastern shoreline and adjacent to the two islands. Six nests were guarded by male smallmouth bass and four of these contained viable eggs. Most nests were located in water depths in excess of three feet. Divers concluded that nesting activity was well underway by these dates.

Construction of redds and egg-laying by brook trout were observed by FPLE and MDIFW divers on October 18, 2002, October 21, 2003, and October 21, 2004 at the Lower Dam and Wing Dam sites (Figure 3). During all years, the highest concentration of brook trout redds was observed in a single area approximately 60 ft wide and 125 ft long. Water depths in this "trough", located downstream of Lower Dam, ranged from 4 to 8 ft. Mounds of gravel interspersed among large boulders and woody debris characterize this site. Brook trout utilized gravels ranging in size from ¼ to 3 inches in diameter that were deep and unconsolidated. Divers estimated that approximately 35 to 45 adult brook

trout utilized this site in 2004. FPLE staff judged this number to be commensurate with those observed in 2002 and 2003 (FPLE 2004).

Several brook trout redds were also observed near the Wing Dam site, above Lower Dam, and near Long Pool (Figure 3). Redds at these sites were located in 1 to 3 feet of water. Divers did not observe eggs in redds at the Long Pool site (FPLE 2004); however, it seemed likely that brook trout redds were present near this site because newly emerged trout fry were observed here in both 2003 and 2004.

There was evidence to suggest that superimposition of salmon redds over brook trout redds occurred in the area below Lower Dam. On March 18, 2003 FPLE divers collected viable eggs from several sites utilized by spawning brook trout in October 2002. Size of eggs excavated in March 2003 (5.7 to 6.6 mm) suggested they were deposited by salmon, and this was later confirmed by DNA analysis (FPLE 2004). On November 6, 2003 and November 9, 2004, FPLE and MDIFW divers observed several salmon constructing redds in the same substrate earlier utilized by brook trout, particularly in the deeper “trough” spawning site. Gravels at this site had been substantially re-excavated by salmon. Divers observed several salmon and hundreds of salmon eggs scattered near the surface of the substrates at the Wing Dam site in 2003. FPLE divers also noted the presence of partially consumed brook trout eggs on exposed rocks, suggesting mammal predation occurred following re-excavation of trout redds by salmon. Identification was made on the basis of egg size.

Salmon redds were observed at several additional locations during all dive surveys. Salmon spawning was observed near the Wingate site (Figure 3) and in several areas above Lower Dam. Water depths at these sites ranged from about 1 to 3 ft and gravels were 2-4 inches in diameter.

The results of these surveys provided strong evidence that salmon compete with brook trout for suitable spawning gravel, which is limited in the Rapid River (DeSandre 1986).

### ***Smallmouth bass food habits***

Food items selected by smallmouth bass in the Rapid River, Pond in the River, and Umbagog Lake are summarized in Table 9. Insects were the most frequently selected food of Rapid River smallmouth bass. Mayflies were the most commonly identified insect group (33% of stomachs) followed by stoneflies, dragonflies, and various dipterans (mosquitoes and midges). Fish species, including juvenile brook trout, juvenile salmon, and juvenile smallmouth bass, were found in 8% of stomachs. Crayfish (*Orconectes* spp.) were consumed by 10% of Rapid River bass sampled.

Pond in the River bass preyed most frequently on crayfish (50%) and a variety of insects. As in the Rapid River, mayfly species were the most commonly identified insect item (21%). Slimy sculpin, yellow perch (*Perca flavescens*), and unidentifiable fish were found in 6% of stomachs with food.

Fish items, including smallmouth bass, were in 13% of bass stomachs with food in Umbagog Lake. Dragonfly species were the dominant insect group identified (40%). Beetles, mayflies, and dipteran species were also common food items. Crayfish were identified in 16% of stomachs.

There were clear differences in foods selected by bass from the three waters. Selection of particular items or groups of items probably reflected the availability of

those foods in the individual waters. This in turn may have been related to the markedly different habitat provided by each, or to the length of time bass have been present in each. The sizes of smallmouth bass sampled from each water were perhaps relevant as well; size of selected food items is often linearly related to the size of individual fish. A more detailed discussion of smallmouth bass food habits will be provided in a separate report.

Food habits data confirmed that smallmouth bass are predators on young brook trout and salmon, and they provide strong circumstantial evidence that they are competing with juvenile salmonids for food resources in the Rapid River. The data also provide important baseline information from which ecological and biological impacts arising from the bass introduction can be assessed.

### ***River temperature regime***

Average monthly water temperatures at four sites showed conditions in the Rapid River were generally suitable for salmonids in 2002 and 2003 (Table 10). Slightly higher monthly averages at the Lower Dam, Smooth Ledge, and Cedar Stump sites showed the warming influence of Pond in the River. The warmest average temperatures occurred in July and August at all sites during both years.

Average daily minimum, mean, and maximum temperatures during July and August exceeded 68°F for a significant number of days at all sites (Table 11). The number of days exceeding 68°F generally increased in a downstream direction, again indicating the warming influence of Pond in the River. Brook trout seek thermal refugia during these periods; salmon are more tolerant of elevated temperatures and can utilize more of the available nursery habitat for longer periods. Average daily maximum temperature exceeded 77°F during several days at Cedar Stump, the lowermost site surveyed, and at the Smooth Ledge site.

July and August temperatures in the Rapid River were similar to those from several nearby streams (Table 11). Salmon are the dominant salmonid in these streams, with the exception of the Moose Bog site on the Magalloway River and the South Branch of the Dead River.

### ***Fish population age and size structure***

Brook trout sampled from the Rapid River and Pond in the River since 1961 were composed primarily of age II+, III+, and IV+ fish (Table 12). Older age brook trout (age IV+ and older) collectively comprised about 29% of samples, indicating conditions for survival were excellent. Length and condition data, most of which was collected since 2002, suggested brook trout growth rates and body condition remained excellent despite recent increases in numbers of smallmouth bass (Table 13).

Salmon populations in the Rapid River and Pond in the River were composed primarily of wild fish (Table 14); wild and hatchery-reared salmon comprised 86% and 14% of the catch, respectively. Wild salmon ranged in age from 0+ to VIII+, while hatchery salmon were ages I+ to VI+. Hatchery salmon were presumed to originate from stockings made in Richardson Lake, though fish planted in waters upstream of Richardson Lake may have contributed small numbers. Sample sizes were too small to characterize growth of cohorts (Table 15), but the combined samples showed that wild salmon exhibit slow growth rates typical of river-resident fish. As noted earlier, most of

the larger salmon are fish that had spent much of their life in the more productive environments of Richardson Lake and Umbagog Lake.

Rapid River smallmouth bass were dominated by age 0 and age I fish (Table 16). The predominance of these two cohorts may have been a consequence of our sampling sites and technique, which primarily consisted of electrofishing in the shallow channel margins that are not generally utilized by adult or older juvenile bass. The presence of younger bass in the shallow fringes of the Rapid River is notable, however, because these same areas are significant brook trout nurseries.

Age III bass dominated the samples from Pond in the River in 2003 (63%); this same cohort continued to be prevalent in 2004 (65% of the catch). Age II bass were also abundant in 2004, comprising 32% of samples.

In Umbagog Lake, smallmouth bass up to age X were present, but age V fish was the predominant cohort in 2004 (Table 18). Older-age bass (age VI and older) were more prevalent in Umbagog Lake than in either the Rapid River or Pond in the River. This reflects the fact that smallmouth bass have been well established in Umbagog for a much longer period than for the other waters.

Mean size at age of smallmouth bass from the three waters is summarized in Tables 19-21. Backcalculated lengths at age (Figure 5) suggested that growth rates were slow in the Rapid River compared to Pond in the River and to other riverine smallmouth bass populations in western Maine. It should be noted, however, that samples of bass older than age II from the Rapid River were small, so this conclusion is preliminary. Growth rates in Pond in the River were comparable to those observed in the other riverine populations, and exceeded those from Umbagog Lake and from 17 lakes in southern Oxford, Franklin, and Somerset Counties. Growth in Umbagog Lake was slowest among all waters or groups of waters compared.

The good growth rates exhibited by Pond in the River bass are probably related to their recent colonization of this lake. We believe bass densities were relatively low in 2003 and 2004 so their food resources were probably not limiting to growth. In contrast, bass densities in Umbagog Lake, where they have been established for about 20 years, appeared to be much higher. Intraspecific food competition may already be limiting bass growth in that lake.

### ***Brook trout genetics study***

Genetic analysis provided information to guide future decisions regarding stock rehabilitation or enhancement of Rapid River brook trout in the event recruitment failure occurs in the presence of smallmouth bass. Results of the genetic tests are excerpted from Fraser et al. (2004):

“The results support the hypothesis that Rapid River brook trout represent a genetically distinct population from brook trout found in the Lower Magalloway River. The results also suggest that Rapid River and Lower Magalloway brook trout are more closely related to each other than to all other populations examined in the Androscoggin and Kennebec River drainages.

“These results suggest that a brood line for Rapid River brook trout started from Rapid River brook trout itself would represent the best approach for population rehabilitation. However, in the event that ample broodstock is unavailable from Rapid River, the next closest potential broodstock source for rehabilitation in the Androscoggin

drainage should come from Lower Magalloway River, followed by Kennebago Lake, and lastly Long Pond {upper Magalloway River drainage}.”

The results also indicated that the degree of divergence of Rapid River brook trout from the Lower Magalloway and Kennebago Lake populations was small and that there continues to be some level of gene flow between the three subpopulations (M. Kennison, University of Maine, and M. Gallagher, MDIFW, personal communication). These facts, and because establishing a separate brood line far exceeds MDIFW’s current and projected infrastructure and staffing capabilities, imply that future stock enhancements, if they become necessary and desirable, will most likely be achieved with the Kennebago Lake strain. Kennebago Lake strain fish have been established as MDIFW’s primary brood stock since 1995, so no additional cost or risks to existing hatchery facilities (from diseases, etc.) would be incurred.

## **RECOMMENDATIONS**

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- Key nursery areas, recently identified, should receive the highest level of protection from potentially adverse land use activities (timber harvesting, road construction/maintenance, seasonal residential developments on the shorefront or in the watershed, etc.). A survey of the Rapid River watershed should be initiated to identify and resolve existing and potential sources of erosion and sedimentation.
- Maintain the connectivity of habitats critical to Rapid River trout. These include Pond in the River and Umbagog Lake, which provide important mid-summer and over wintering habitat for Rapid River trout.
- Landlocked salmon, which were introduced to this drainage late in the 19<sup>th</sup> century, are competitors with trout in the Rapid River. Competition for limited spawning substrate was documented, and there was evidence that young salmon compete with trout for nursery space, particularly during the late summer period. In addition, strong competition for food likely occurs among most age classes of each species. Salmon numbers should be reduced by relaxing harvest regulations (completed in 2004) and, if feasible, by manipulating flows from Middle Dam to favor trout over salmon.
- Initiate studies to evaluate the feasibility of manipulating flow velocities in the Rapid River during key smallmouth bass life history periods as a means of negatively impacting smallmouth bass recruitment and growth processes. Review existing Instream Flow data to identify potential data gaps relative to smallmouth bass and landlocked salmon control objectives, and obtain preliminary recommendations for targeted impact flows that are compatible with other uses within the storage system.
- Initiate telemetry studies to identify the temporal/spatial distribution of juvenile trout (age I and age II) and smallmouth bass in the Rapid River, and evaluate the

efficacy of targeted removal of smallmouth bass from critical brook trout nursery habitat.

- Initiate telemetry studies in the lower Magalloway River to identify critical trout spawning and nursery sites, seasonal habitat use patterns, and the degree of genetic exchange with the Rapid River brook trout population. Collect similar data for landlocked salmon and smallmouth bass ancillary to this project.
- Design and disseminate informational signage/brochures to alert the general public to problems arising from illegal fish stocking and criminal penalties associated with illegal stocking. Design and disseminate informational signage/brochures to alert anglers of the merits of increasing bass and salmon harvest rates in the Rapid River.
- Establish rigorous protocols for monitoring trends in the sport fisheries and spawning and recruitment success of salmonids and smallmouth bass. Continue to monitor age, growth, and size structure of salmonids and bass.
- If natural brook trout recruitment fails due to bass predation and competition, replacing lost juvenile production with hatchery fish may be the most effective, realistic means of mitigating the presence of bass and preserving sport fishing opportunities. With input from anglers, develop criteria for determining when brook trout recruitment failure has occurred, define risks to remaining Rapid River-strain trout associated with hatchery supplementation, and develop stock enhancement and evaluation strategies that minimize risks while supporting a viable sport fishery.

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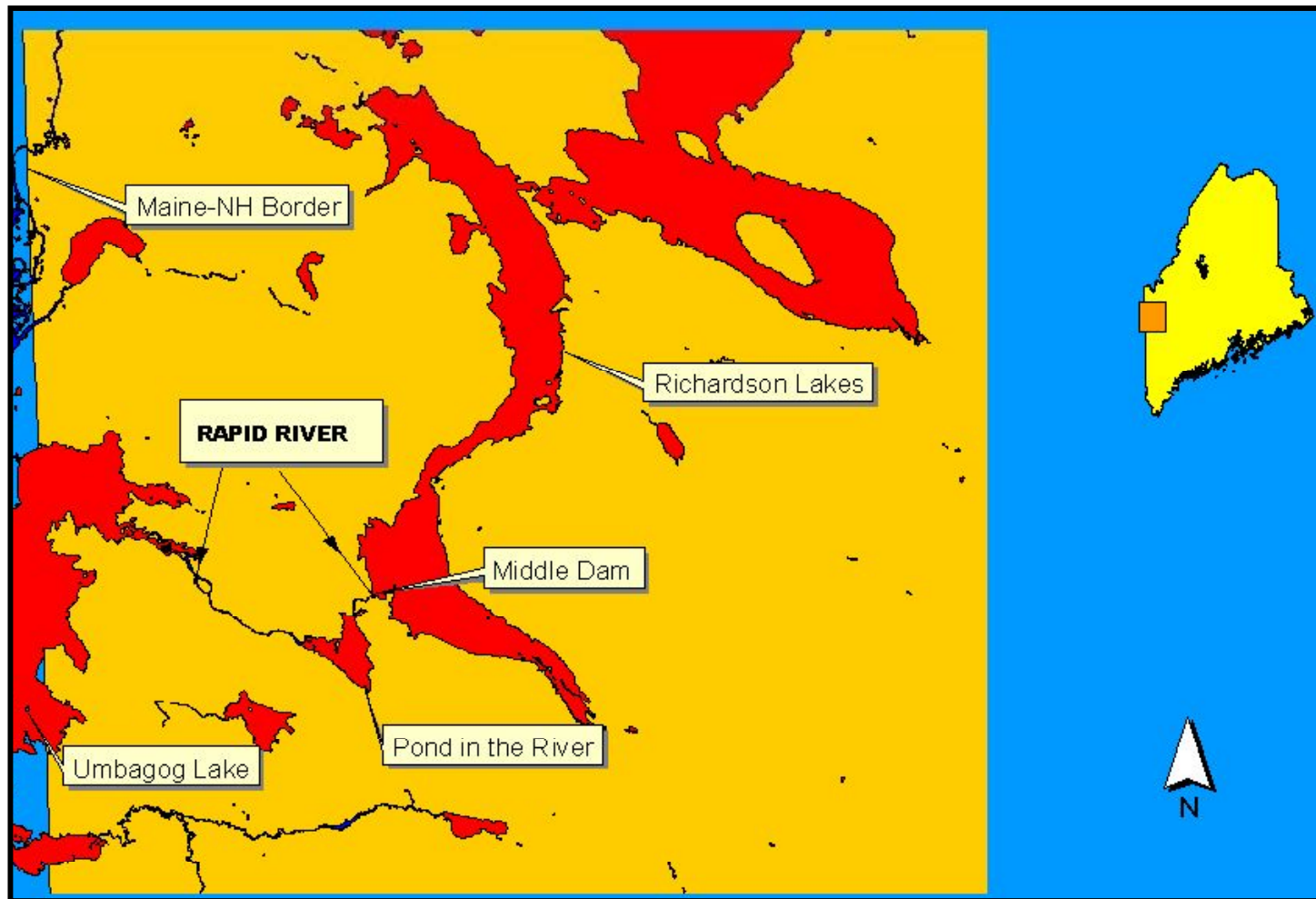
Prepared by:  
David P. Boucher  
February 2005

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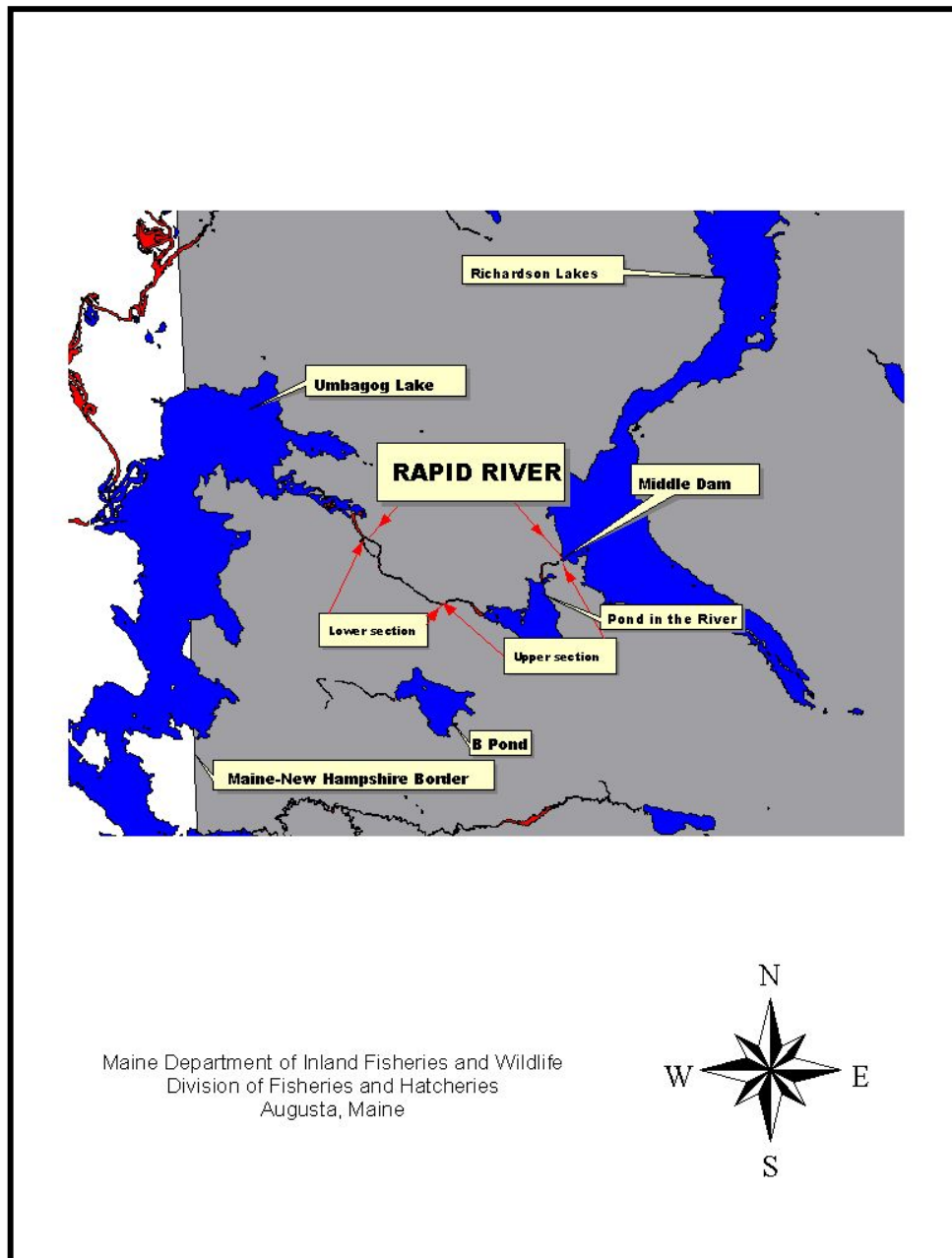
Figure 1. Site location map for Rapid River and Pond in the River, Oxford County, Maine.



**Table 1. Description of Rapid River clerk creel surveys.**

<b>Year</b>	<b>Date</b>	<b>No. days surveyed</b>	<b>No. days in season</b>
1994	May 13–September 30	43	183
1998	May 11–September 30	31	183
1999	May 14–September 30	28	183
2002	May 14–September 30	43	183
2003	May 3–September 30	49	183
2004	May 1–September 30	45	183

**Figure 2. Site location map for Rapid River creel surveys, 1994-2004.**



**Table 2. Angler effort estimates for the Rapid River, 1994-2004. Confidence limits (95%) are in parenthesis.**

	Upper reach (1.3 miles)		Lower reach (1.9 miles)		Both reaches (3.2 miles)	
Year	Trips	Trips/mile	Trips	Trips/mile	Trips	Trips/mile
1994	6,892 (1,458)	5,302 (1,122)	873 (375)	459 (197)	<b>7,830 (1,586)</b>	<b>2,447 (496)</b>
1998	6,471 (2,099)	4,978 (1,615)	677 (477)	356 (251)	<b>7,035 (2,208)</b>	<b>2,198 (690)</b>
1999	8,317 (2,025)	6,398 (1,558)	760 (626)	400 (329)	<b>8,728 (2,133)</b>	<b>2,728 (667)</b>
2002	4,446 (1,275)	3,420 (981)	531 (324)	279 (171)	<b>4,926 (1,358)</b>	<b>1,539 (424)</b>
2003	5,255 (1,252)	4,042 (963)	180 (131)	95 (69)	<b>5,435 (1,298)</b>	<b>1,698 (406)</b>
2004	4,686 (1,265)	3,605 (973)	425 (285)	223 (150)	<b>5,101 (1,366)</b>	<b>1,594 (427)</b>

**Table 3. Recent angler use estimates from several Maine riverine salmonid fisheries.**

River (reach)	Year	Miles	Angler trips±95% CI	Trips/mile±95% CI
Upper Dam Pool	2003	0.46	2,804±442	6,096±961
Upper Dam Pool	1999	0.46	2,618±666	5,691±1,448
Upper Dam Pool	2002	0.46	2,265±550	4,924±1,196
Upper Dam Pool	2004	0.46	2,092±412	4,548±896
Upper Dam Pool	1998	0.46	1,836±318	3,991±691
Presumpscot R. (Eel Weir Bypass)	1995	1.3	6,826±1,477	5,251±1,136
Presumpscot R. (Eel Weir Bypass)	1998	1.3	6,126±1,218	4,712±940
Presumpscot R. (Eel Weir Bypass)	1997	1.3	5,389±1,068	4,145±822
Presumpscot R. (Eel Weir Bypass)	1996	1.3	4,418±1,514	3,399±1,165
Presumpscot R. (Eel Weir Bypass)	1994	1.3	3,662±974	2,817±749
<b>Rapid River</b>	<b>1999</b>	<b>3.2</b>	<b>8,728±2,133</b>	<b>2,728±667</b>
<b>Rapid River</b>	<b>1994</b>	<b>3.2</b>	<b>7,830±1,586</b>	<b>2,447±496</b>
<b>Rapid River</b>	<b>1998</b>	<b>3.2</b>	<b>7,035±2,208</b>	<b>2,198±690</b>
<b>Rapid River</b>	<b>2003</b>	<b>3.2</b>	<b>5,435±1,298</b>	<b>1,698±406</b>
<b>Rapid River</b>	<b>2004</b>	<b>3.2</b>	<b>5,101±1,366</b>	<b>1,594±427</b>
<b>Rapid River</b>	<b>2002</b>	<b>3.2</b>	<b>4,926±1,358</b>	<b>1,539±424</b>
Kennebec River (East Outlet)	1990	2.8	4,705	1,680
Kennebec River (Abenaki Dam tailwater)	1999	1.8	567±237	308±129
W. Branch Penobscot River (Ripogenous Dam to Abol Bridge)	1991	11.0	9,079±451	825±41
W. Branch Penobscot River (Below Seboomook Dam)	1994	4.0	1,263±187	316±48
Grand Lake Stream	1992	2.75	1,132±359	412±131
Grand Lake Stream	1993	2.75	762±357	277±130
Magalloway River (below Aziscohos L.)	1998	6.8	2,074±514	310±76
Magalloway River (below Aziscohos L.)	2003	6.8	1,819±561	268±83
Magalloway River (below Aziscohos L.)	2004	6.8	1,622±409	239±60
Magalloway River (below Aziscohos L.)	2002	6.8	1,601±456	235±67
Magalloway River (below Aziscohos L.)	1999	6.8	1,234±266	182±39

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**Table 4. Summary statistics for Rapid River clerk creel surveys, 1994-2004<sup>1</sup>.**

Parameter	Species	Survey year					
		1994	1998	1999	2002	2003	2004
No. anglers surveyed		167	210	158	357	721	689
No. hours surveyed		713	882	1,004	1,391	2,545	2,554
No. (%) successful anglers	Brook trout	38 (23)	49 (23)	39 (25)	72 (20)	169 (23)	131 (19)
	Salmon	48 (29)	83 (40)	66 (42)	77 (22)	161 (22)	179 (26)
	Smallmouth bass	0	0	2 (1)	6 (2)	26 (4)	50 (7)
No. legals caught <sup>2</sup>	Brook trout	64	176	83	155	366	226
	Salmon	87	244	138	190	279	318
	Smallmouth bass	0	0	6	13	68	135
No. (%) legals released	Brook trout	64 (100)	176 (100)	83 (100)	155 (100)	366 (100)	226 (100)
	Salmon	86 (99)	242 (99)	135 (98)	190 (100)	278 (99)	315 (99)
	Smallmouth bass	0	0	6 (100)	8 (62)	17 (25)	7 (5)
No. (%) sublegals	Brook trout	38 (37)	221 (56)	186 (69)	144 (48)	143 (28)	173 (43)
	Salmon	156 (64)	215 (47)	158 (53)	413 (68)	631 (69)	320 (50)
	Smallmouth bass	0	0	0	*	*	*
Catch/hour (legals)	Brook trout	0.095	0.172	0.104	0.152	0.130	0.086
	Salmon	0.131	0.321	0.160	0.154	0.114	0.134
	Smallmouth bass	0	0	0.009	0.011	0.050	0.065
Catch/hour (sublegals)	Brook trout	0.049	0.307	0.219	0.128	0.061	0.080
	Salmon	0.214	0.330	0.191	0.389	0.269	0.147
	Smallmouth bass	0	0	0	*	*	*
Estimated no. legals caught <sup>3</sup>	Brook trout	2,975±603	5,909±1,855	4,626±1,130	2,119±584	2,772±662	1,673±448
	Salmon	4,072±825	8,161±2,561	7,593±1,856	2,611±720	2,120±507	2,357±631
	Smallmouth bass	0	0	349±85	197±54	489±117	1,000±268
Percent complete trips		84	34	40	33	9	14

<sup>1</sup> Mean catch/ hour computed from both complete and incomplete trips. Catch rates reported in earlier reports were expressed as catch per trip for complete trips only. Confidence limits (±), where reported, are at 95%.

<sup>2</sup> For the purpose of this summary trout 12 inches and longer were considered legal fish during all years. Legal salmon were 14 inches prior to 2004 and 12 inches in 2004.

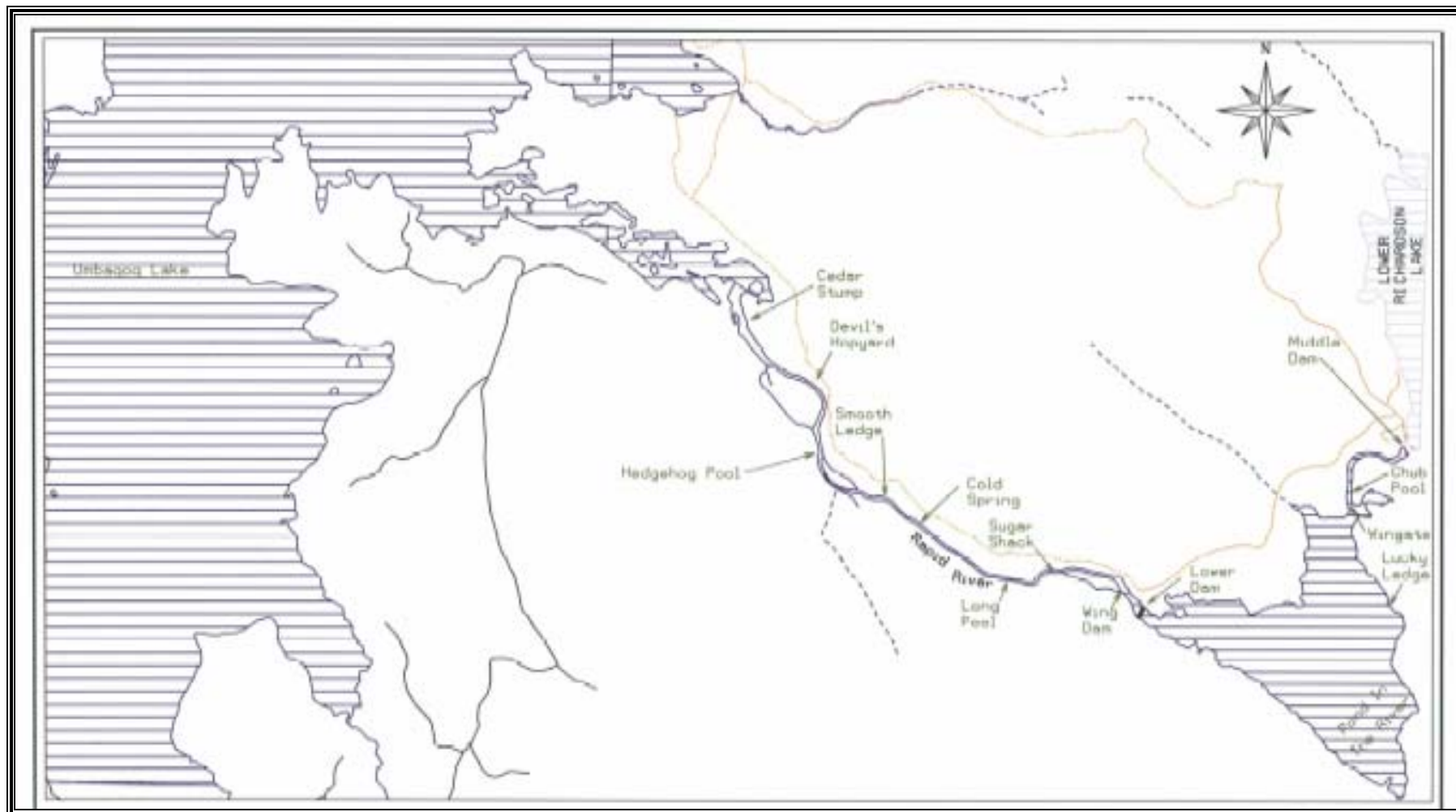
<sup>3</sup> Total catch estimated from catch/angler trip (total ratio estimator).

**Table 5. Summary statistics for Rapid River voluntary surveys, 1998-2004**

Parameter	Species	Survey year						
		1998	1999	2000	2001	2002	2003	2004
No. anglers surveyed		218	130	223	161	167	151	155
No. hours surveyed		560	303	795	521	521	494	504
No. (%) successful anglers	Brook trout	40 (18)	22 (17)	75 (34)	51 (32)	79 (47)	50 (33)	59 (38)
	Salmon	67 (31)	23 (18)	63 (28)	63 (28)	42 (25)	47 (31)	68 (44)
	Smallmouth bass	3 (1)	2 (2)	4 (2)	4 (2)	19 (11)	14 (9)	29 (19)
No. legals caught <sup>4</sup>	Brook trout	62		128	96	112	98	88
	Salmon	100	39	93	94	132	94	134
	Smallmouth bass	5	2	7	15	28	40	88
No. (%) legals released	Brook trout	62 (100)	39 (100)	128 (100)	96 (100)	112 (100)	98 (100)	88 (100)
	Salmon	95 (95)	39 (100)	92 (99)	92 (98)	131 (99)	94 (100)	120 (90)
	Smallmouth bass	5 (100)	1 (50)	1 (14)	0 (0)	3 (11)	12 (30)	31 (35)
No. (%) sublegals	Brook trout	142 (70)	60 (39)	72 (36)	112 (54)	69 (35)	24 (20)	50 (36)
	Salmon	376 (79)	119 (75)	221 (70)	157 (63)	138 (55)	101 (52)	108 (45)
	Smallmouth bass	5 (50)	0	*	*	*	*	*
Catch/hour (legals)	Brook trout	0.094	0.103	0.225	0.312	0.324	0.222	0.229
	Salmon	0.223	0.130	0.139	0.197	0.259	0.212	0.343
	Smallmouth bass	0.002	0.011	0.018	0.033	0.052	0.109	0.256
Catch/hour (sublegals)	Brook trout	0.321	0.271	0.228	0.594	0.168	0.090	0.248
	Salmon	1.145	0.626	0.566	0.616	0.397	0.258	0.317
	Smallmouth bass	0.002	0	*	*	*	*	*
Mean length (inches) of fish reported $\pm$ SE	Brook trout	14.3 $\pm$ 0.4	15.1 $\pm$ 0.5	14.6 $\pm$ 0.2	15.0 $\pm$ 0.3	16.0 $\pm$ 0.2	15.8 $\pm$ 0.3	15.2 $\pm$ 0.2
	Salmon	15.5 $\pm$ 0.2	15.2 $\pm$ 0.2	15.6 $\pm$ 0.2	15.7 $\pm$ 0.2	16.2 $\pm$ 0.2	16.4 $\pm$ 0.2	14.2 $\pm$ 0.2
	Smallmouth bass	12.4 $\pm$ 0.2	16.0 $\pm$ 0.2	14.8 $\pm$ 0.8	7.8 $\pm$ 1.2	7.4 $\pm$ 0.5	7.6 $\pm$ 0.5	5.5 $\pm$ 0.3

<sup>4</sup> For the purpose of this summary trout 12 inches and longer were considered legal fish during all years. Legal salmon were 14 inches prior to 2004 and 12 inches in 2004.

Figure 3. Rapid River telemetry study area. Map provided by E-PRO Engineering and Environmental Consulting, LLC, Augusta, ME.



**Table 6. Summary of Rapid River brook trout movements from radio telemetry study, 2002-2003 (FPLE 2004). Shaded cells indicate dates and locations where tagged brook trout were concentrated (see Figure 3 for location descriptions).**

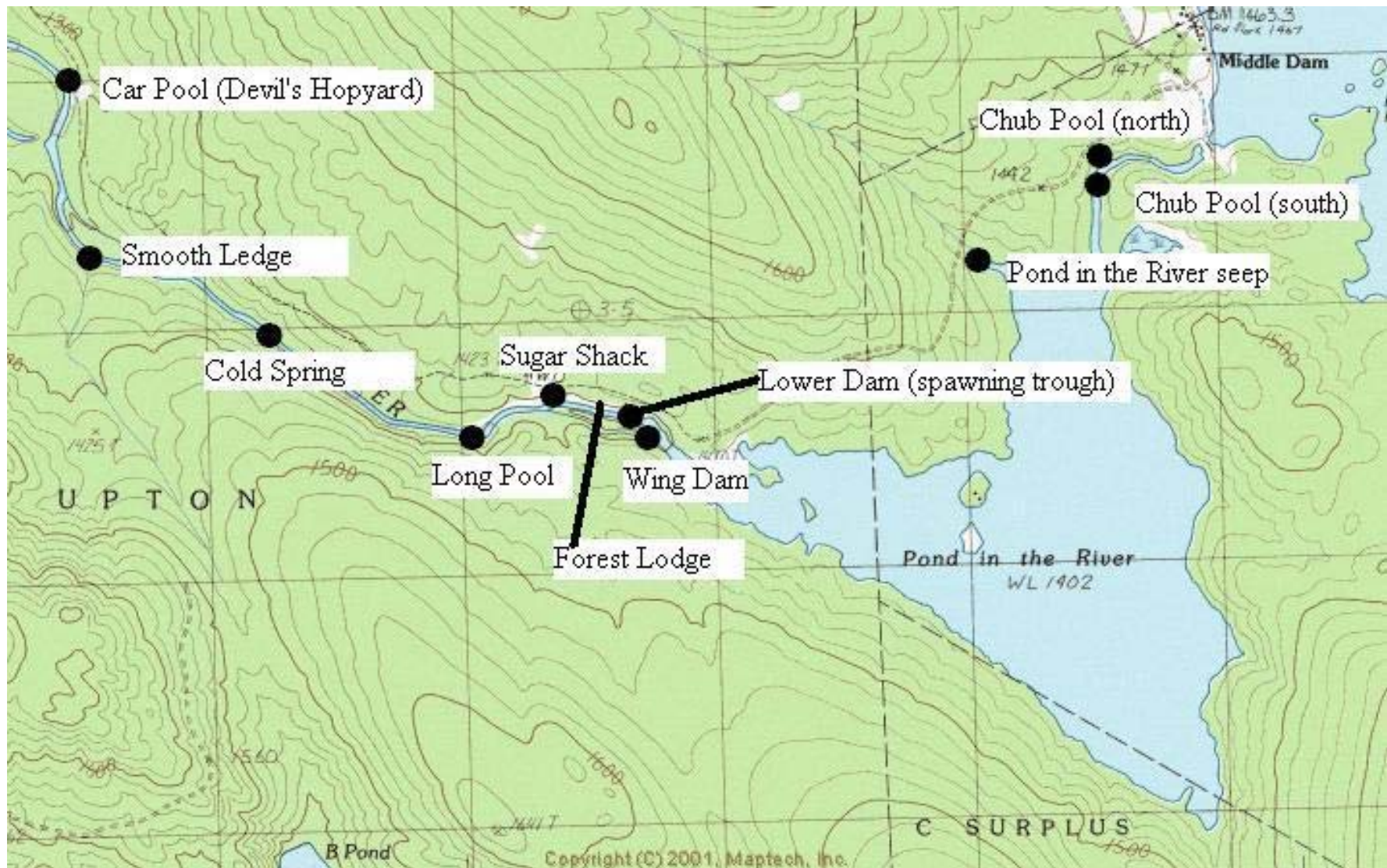
	DATE RANGE					
LOCATION	June 25-July 15 (No. obs. = 64)	July 16-August 31 (No. obs. = 83)	Sept. 1 to Sept 30 (No. obs. = 64)	Oct. 1 to Oct 31 (No. obs. = 97)	Nov. 1 to March 18 (No. obs. = 104)	April 1 to May 31 (no. obs. = 21)
NUMBER OF OBSERVATIONS (%) AT EACH SITE ON THESE DATES						
Middle Dam	12 (18)	2 (2)	3 (5)	2 (2)	9 (9)	3 (14)
Wingate	15(23)	12 (14)	8 (13)	9 (9)	6 (6)	3 (14)
Pond in the River	12 (18)	60 (72)	30 (47)	10 (10)	45 (45)	6 (30)
Lower Dam	5 (8)	2 (2)	15 (23)	25 (26)	3 (3)	0
Wing Dam	5 (8)	0	3 (5)	18 (18)	0	0
Long Pool	1 (2)	5 (6)	4 (6)	12 (12)	0	0
Smooth Ledge	7 (11)	1 (1)	0	3 (3)	21 (21)	3 (14)
Cedar Stump	1 (2)	0	1 (2)	1 (1)	3 (3)	3 (14)
Umbagog Lake	6 (9)	1 (1)	0	5 (5)	17 (17)	3 (14)

Table 7. Summary of trapnet collections, Pond in the River, May 6-23, 2003.

Date tended	Water Temp. (°F)	Number captured of: <sup>5</sup>														
		BKT	LLS	SMB	YLP	WHS	LNS	FLF	LCB/PRD	CMS	CCB	BND	PKS	SCL	BUL	CRA
May 8	50	0	0	0	0	164	0	100	18	1	0	0	0	0	1	4
May 12	48	2	0	0	0	56	0	15	5	1	0	0	1	0	1	0
May 14	50	3	1	0	5	83	0	12	15	2	1	0	0	1	0	0
May 16	49	4	3	0	3	42	0	9	3	0	0	0	0	0	1	0
May 19	60	0	0	5	6	157	0	22	0	10	0	4	4	0	1	4
May 21	59	0	0	2	2	310	1	48	18	14	1	0	10	0	1	6
May 23	59	2	1	2	1	111	0	8	9	9	0	0	1	1	0	4
<b>Totals:</b>		<b>11</b>	<b>5</b>	<b>7</b>	<b>17</b>	<b>923</b>	<b>1</b>	<b>214</b>	<b>68</b>	<b>37</b>	<b>2</b>	<b>4</b>	<b>16</b>	<b>2</b>	<b>5</b>	<b>18</b>
<b>% of total catch:</b>		<b>0.8</b>	<b>0.4</b>	<b>0.7</b>	<b>1.3</b>	<b>70.4</b>	<b>&lt;0.1</b>	<b>16.3</b>	<b>5.2</b>	<b>2.8</b>	<b>0.1</b>	<b>0.3</b>	<b>1.2</b>	<b>0.1</b>	<b>0.4</b>	<b>*</b>
<b>No./net-day:</b>		<b>0.37</b>	<b>0.17</b>	<b>0.30</b>	<b>0.57</b>	<b>30.8</b>	<b>0.03</b>	<b>7.13</b>	<b>2.27</b>	<b>1.23</b>	<b>0.07</b>	<b>0.13</b>	<b>0.53</b>	<b>0.07</b>	<b>0.17</b>	<b>0.60</b>
<b>No./net-hour:</b>		<b>0.015</b>	<b>0.007</b>	<b>0.013</b>	<b>0.024</b>	<b>1.28</b>	<b>0.001</b>	<b>0.298</b>	<b>0.093</b>	<b>0.051</b>	<b>0.003</b>	<b>0.006</b>	<b>0.022</b>	<b>0.003</b>	<b>0.007</b>	<b>0.025</b>

<sup>5</sup> BKT=Brook trout; LLS=Landlocked salmon; SMB=Smallmouth bass; YLP=Yellow perch (*Perca flavescens*); WHS=White sucker; LNS=Longnose sucker (*Catostomus catostomas*); FLF=Fallfish; LCB=Lake chub; PRD=Pearl dace (*Semotilus margarita*); CMS=Common shiner (*Notropis cornutus*); CCB=Creek chub (*Semotilus atromaculatus*); BND=Blacknose dace; PKS=Pumpkinseed sunfish (*Lepomis gibbosus*); SCL=Slimy sculpin; BUL=Brown bullhead (*Ameiurus nebulosus*); CRA=Crayfish.

Figure 4. Locations of juvenile brook trout thermal refuges, 2003 and 2004.



**Table 8. Summary of Rapid River salmonid fry habitat surveys, 2003.**

Site (↓) <sup>6</sup>	DATE	Flow (cfs)	Temp (°C)	No. (%) BKT	No. (%) LLS	No. (%) SMB	Other spp
Middle Dam tailrace	6/4/03	382	11.5	5 (83)	0 (0)	1 (17)	*
	6/18/03	382	16.0	1 (100)	0 (0)	0 (0)	*
	7/2/03	932	20.0	0 (0)	0 (0)	0 (0)	BND/FLF/WHF/LCB/YLP/CRA
	7/16/03	800	21.0	2 (67)	0 (0)	1 (33)	BND/FLF/CRA
	7/31/03	400	21.5	1 (100)	0 (0)	0 (0)	BND/LND/CMS
	9/5/03	600	*	0 (0)	0 (0)	4 (100)	*
Wingate	5/29/03	200	12.5	2 (100)	0 (0)	0 (0)	*
	6/4/03	382	11.5	8 (54)	2 (13)	5 (33)	*
	6/18/03	382	16.0	12 (92)	0 (0)	1 (8)	BND/LND/WHF/YLP
	7/2/03	932	21.0	1 (100)	0 (0)	0 (0)	BND/LND/CMS/FLF/YLP
	7/16/03	800	21.0	0 (0)	0 (0)	2 (100)	BND/LND/FLF/YLP/CRA
Lower Dam (above-north shore)	6/4/03	382	15.0	4 (36)	3 (27)	4 (36)	BND/LND/CMS/WHF/CRA
	6/18/03	382	17.0	3 (75)	1 (25)	0 (0)	BND/LND/CMS/CRA
	7/2/03	932	22.0	0 (0)	0 (0)	11 (100)	BND/CMS/FLF/YLP/CRA
	9/10/03	600	19.0	0 (0)	0 (0)	2 (100)	
Lower Dam (spawning trough site)	6/4/03	382	15.0	19 (53)	13 (36)	4 (11)	LND/CMS/CRA
	6/11/03	482	15.5	26 (68)	11 (29)	1 (3)	LND/CMS/CRA
	6/18/03	382	17.0	26 (84)	5 (16)	0 (0)	LND/CRA
	7/2/03	932	22.0	14 (88)	1 (6)	1 (6)	*
	7/16/03	800	21.0	1 (20)	4 (80)	0 (0)	LND/FLF
	7/31/03	400	21.5	0 (0)	7 (100)	0 (0)	*
	9/10/03	600	18.5	0 (0)	6 (75)	2 (25)	NONE
Wing Dam	6/4/03	382	15.0	14 (64)	8 (36)	0 (0)	WHF
	6/18/03	382	17.0	19 (58)	14 (42)	0 (0)	BND/LND/CRA
	7/16/03	800	20.0	13 (76)	4 (24)	0 (0)	NONE
	7/31/03	400	22.0	15 (54)	13 (46)	0 (0)	NONE
	9/10/03	600	19.0	12 (57)	7 (33)	2 (10)	NONE
Forest Lodge	5/29/03	200	13.0	3 (100)	0 (0)	0 (0)	*
	6/4/03	382	15.0	13 (65)	7 (35)	0 (0)	BND/CMS/CRA
	7/31/03	400	21.5	0 (0)	7 (70)	3 (30)	NONE
	9/10/03	600	19.5	0 (0)	1 (100)	0 (0)	CMS/FLF

<sup>6</sup> Sites are listed from upstream to downstream.

<b>Table 8 (cont') Site (↓)</b>	<b>DATE</b>	<b>Flow (cfs)</b>	<b>Temp (°C)</b>	<b>No. (%) BKT</b>	<b>No. (%) LLS</b>	<b>No. (%) SMB</b>	<b>Other spp</b>
Sugar Shack	7/2/03	932	22.0	13 (93)	1 (7)	0 (0)	BND/FLF
	7/16/03	800	20.0	9 (90)	1 (10)	0 (0)	NONE
	7/31/03	400	21.0	12 (55)	7 (32)	3 (14)	NONE
	9/10/03	600	19.0	1 (9)	6 (55)	4 (36)	CMS/WHs
Long Pool	5/29/03	200	13.0	1 (50)	1 (50)	0 (0)	*
	6/4/03	382	15.0	11 (61)	7 (39)	0 (0)	BND/LND/FLF/CRA
	06/11/03	482	15.5	13 (81)	3 (19)	0 (0)	BND/LND/CMS
	6/18/03	382	17.0	16 (84)	2 (11)	1 (5)	*
	7/2/03	932	22.0	9 (69)	1 (8)	3 (23)	BND/LND/CMS
	7/16/03	800	20.5	2 (100)	0 (0)	0 (0)	*
	9/10/03	600	18.5	0 (0)	1 (33)	2 (67)	LND/CMS/FLF/WHs/CRA
Cold Spring Pool	6/4/03	382	15.0	4 (40)	5 (50)	1 (10)	CMS/CRA
	6/18/03	382	17.0	4 (80)	1 (20)	0 (0)	BND/LND/CMS/WHs
	7/2/03	932	22.0	8 (100)	0 (0)	0 (0)	BND/FLF
	7/16/03	800	20.5	2 (100)	0 (0)	0 (0)	NONE
	7/31/03	400	21.0	2 (100)	0 (0)	0 (0)	BND
	9/10/03	600	18.5	1 (50)	1 (50)	0 (0)	LND/CMS/FLF/CRA
Smooth Ledge	6/4/03	382	15.0	12 (55)	6 (27)	4 (18)	LND/CMS/WHs/CRA
	6/18/03	382	17.0	0 (0)	0 (0)	0 (0)	BND/LND/CMS/WHs/CRA
	7/2/03	932	22.0	2 (67)	0 (0)	1 (33)	BND/LND/CMS/FLF
	7/16/03	800	20.5	0 (0)	0 (0)	0 (0)	NONE
	9/10/03	600	18.5	0 (0)	1 (20)	4 (80)	LND/CMS/FLF
Hedgehog Pool	5/29/03	200	13.5	0 (0)	0 (0)	1 (100)	*
	6/4/03	382	15.0	0 (0)	0 (0)	1 (100)	*
Devil's Hopyard (Car Pool)	7/16/03	800	20.5	0 (0)	0 (0)	0 (0)	NONE
	7/31/03	400	21.0	1 (25)	0 (0)	3 (75)	NONE
	9/10/03	600	18.5	0 (0)	0 (0)	1 (100)	BND/LND/CMS

**Table 9. Stomach analysis (frequency of occurrence) of smallmouth bass collected from the Rapid River, Pond in the River, and Umbagog Lake, 2003-2004.**

	Rapid River		Pond in the River		Umbagog Lake	
	No. stomachs examined:		83		99	
	No. stomachs with food:		77		86	
	Mean length (in)/weight (lb) of fish sampled:		3.5/0.05		10.1/0.49	
	Length range of fish sampled (in):		2.2-11.6		5.4-15.6	
TAXA	Number of stomachs	Percent occurrence	Number of stomachs	Percent occurrence	Number of stomachs	Percent occurrence
Decapoda (crayfish)	8	10.4	58	50.4	14	16.3
Amphipoda (freshwater shrimp)	0	0	1	0.9	1	1.2
Plecoptera (stoneflies)	4	5.2	5	4.3	1	1.2
Ephemeroptera (mayflies)	25	32.5	24	20.9	12	13.9
Odonata (dragonflies)	4	5.2	9	7.8	34	39.5
Trichoptera (caddis)	3	3.9	4	3.5	0	0
Coleoptera (beetles)	1	1.3	4	3.5	14	16.3
Diptera (mosquitoes, midges)	4	5.2	3	2.6	11	12.8
Hymenoptera (ants, wasps)	0	0	1	0.9	0	0
Unidentified insect remains	56	72.7	40	34.8	60	69.8
Brook trout	1	1.3	0	0	0	0
Landlocked salmon	1	1.3	0	0	0	0
Yellow perch	0	0	1	0.9	0	0
Smallmouth bass	1	1.3	0	0	1	1.2
Slimy sculpin	0	0	1	0.9	0	0
Unidentified fish remains	3	3.9	5	4.4	10	11.6
Vegetation	1	1.3	2	1.7	4	4.7

**Table 10. Average monthly water temperatures (°F) at several sites on the Rapid River, 2002-2003 (FPLE data).**

		Site			
Month	Year	Middle Dam	Lower Dam	Smooth Ledge	Cedar Stump
March	2002	35	35	*	*
April	2002	38	39	*	*
May	2002	44	46	*	*
June	2002	56	57	64	64
July	2002	67	68	68	68
August	2002	71	71	71	71
September	2002	64	65	65	65
October	2002	53	53	52	52
November	2002	41	39	39	39
December	2002	34	34	34	33
January	2003	34	34	33	33
February	2003	33	33	33	33
March	2003	34	34	34	34
April	2003	37	37	38	38
May	2003	48	51	51	51
June	2003	60	62	62	62
July	2003	69	70	70	70
August	2003	71	72	72	71
September	2003	65	66	66	66

**Table 11. July and August temperature regimes (°F) for several western Maine rivers, 1994-2003.**

			<b>Minimum temperature</b>	<b>Mean temperature</b>	<b>Maximum temperature</b>	
<b>SITE</b>	<b>Year</b>	<b>Daily Mean</b>	<b>No. days ≥68°F</b>	<b>No. days ≥68°F</b>	<b>No. days ≥68°F</b>	<b>No. days ≥77°F</b>
Rapid River (Middle Dam)	2002	68.4	17	24	41	0
	2003	69.6	37	50	58	0
Rapid River (Lower Dam)	2002	69.1	30	34	40	0
	2003	70.5	56	58	59	0
Rapid River (Smooth Ledge)	2002	69.3	33	45	52	0
	2003	70.1	50	58	61	15
Rapid River (Cedar Stump)	2002	69.4	30	46	53	2
	2003	70.1	47	57	59	0
Magalloway River (Moose Bog)	2000	62.2	0	3	14	0
Magalloway River (No. 10 Bridge)	2001	68.7	17	35	51	10
Kennebago River (lower reach)	1994	66.0	5	23	54	11
Long Pond Stream (lower reach)	2002	65.1	6	12	30	0
Dodge Pond Stream	2003	71.6	51	55	59	10
Round Pond Outlet	2003	71.2	47	52	56	12
South Branch Dead River (upper reach)	2003	65.1	1	9	37	0
North Branch Dead River (@Chain of Ponds outlet)	2003	69.1	24	39	53	7
Horseshoe Stream	2002	69.8	20	40	59	21

---

**Table 12. Age group composition of Rapid River and Pond in the River brook trout, 1961-2004 (young-of-year fish collected in 2003 and 2004 excluded).**

<b>Age</b>	<b>Number (%) at age</b>
I+	11 (7.4)
II+	58 (39.2)
III+	45 (30.4)
IV+	18 (12.1)
V+	13 (8.8)
VI+	2 (1.4)
VII+	1 (0.7)

---

**Table 13. Mean length (inches), weight (lbs), and condition (K) at age of Rapid River and Pond in the River brook trout, 1961-2004. Standard errors are in parentheses.**

<b>Age</b>	<b>Length</b>	<b>Weight</b>	<b>K</b>
0+	1.8 (0.02)	*	*
I+	6.3 (0.3)	0.1 (0.01)	1.03 (0.12)
II+	10.5 (0.2)	0.5 (0.02)	1.05 (0.02)
III+	13.1 (0.2)	0.9 (0.1)	1.05 (0.02)
IV+	16.5 (0.4)	1.9 (0.2)	1.14 (0.04)
V+	19.0 (0.5)	2.6 (0.3)	1.04 (0.05)
VI+	18.5 (0.2)	2.5 (0.01)	1.07 (0.03)
VII+	19.7 (0)	3.3 (0)	0.18 (0)
<b>All ages (except 0+)</b>	<b>12.4 (0.3)</b>	<b>0.9 (0.1)</b>	<b>1.04 (0.01)</b>

---

**Table 14. Age group composition and origin of Rapid River and Pond in the River salmon, 1961-2004 (young-of-year fish collected in 2003 and 2004 excluded).**

Age	Number (%) at age		
	Wild fish	% Wild fish	Hatchery fish
I+	8 (6.9)	50	4 (21.1)
II+	23 (19.8)	85	4 (21.1)
III+	23 (19.8)	82	5 (26.3)
IV+	26 (22.4)	90	3 (15.8)
V+	16 (13.8)	89	2 (10.5)
VI+	14 (12.1)	93	1 (5.3)
VII+	4 (3.5)	100	0
VIII+	2 (1.7)	100	0
<b>No. (%) by origin</b>	<b>116 (86)</b>		<b>19 (14)</b>

**Table 15. Mean length (inches), weight (lbs), and condition (K) at age of Rapid River and Pond in the River salmon, 1961-2004. Standard errors are in parentheses.**

Age	Wild fish				Hatchery fish		
	Length	Weight	K		Length	Weight	K
0+	1.8 (0.04)	*	*		*	*	*
I+	6.7 (0.3)	0.1 (0.01)	0.85 (0.02)		10.0 (0.2)	0.3 (0.03)	0.81 (0.04)
II+	9.2 (0.2)	0.3 (0.02)	0.89 (0.03)		12.9 (0.4)	0.6 (0.1)	0.76 (0.01)
III+	11.7 (0.3)	0.5 (0.1)	0.79 (0.03)		14.2 (0.8)	0.9 (0.2)	0.81 (0.04)
IV+	14.0 (0.4)	1.0 (0.1)	0.88 (0.03)		13.9 (0.8)	0.9 (0.2)	0.90 (0.04)
V+	15.7 (0.3)	1.2 (0.1)	0.84 (0.04)		17.2 (0.4)	1.1 (0.1)	0.78 (0.15)
VI+	16.9 (0.6)	1.5 (0.1)	0.82 (0.04)		26.8 (0)	4.5 (0)	0.65 (0)
VII+	18.2 (0.6)	2.1 (0.5)	0.92 (0.12)		*	*	*
VIII+	19.1 (0.5)	2.2 (0.3)	0.85 (0.07)		*	*	*
<b>All ages (except 0+)</b>	<b>12.8 (0.3)</b>	<b>0.8 (0.1)</b>	<b>0.85 (0.01)</b>		<b>13.8 (0.9)</b>	<b>0.9 (0.2)</b>	<b>0.80 (0.02)</b>

---

**Table 16. Age group composition of Rapid River smallmouth bass, 2002-2004.**

Age	Number (%) at age
0	33 (35.1)
I	47 (50.0)
II	2 (2.1)
III	5 (5.3)
IV	4 (4.3)
V	0 (0)
≥VI	3 (3.2)

---

**Table 17. Age group composition of Pond in the River smallmouth bass, 2003 and 2004.**

Age	Number (%) at age during:	
	2003	2004
0	6 (10.7)	0 (0)
I	9 (16.1)	2 (2.2)
II	2 (3.6)	29 (31.9)
III	35 (62.5)	1 (1.1)
IV	3 (5.4)	59 (64.8)
V	1 (1.8)	0 (0)

---

**Table 18. Age group composition of Umbagog Lake smallmouth bass, 2003-2004.**

Age	Number (%) at age
0	0 (0)
I	0 (0)
II	2 (2.8)
III	7 (9.9)
IV	3 (4.2)
V	21 (29.6)
≥VI	38 (53.5)

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**Table 19. Mean length (inches) and weight (lbs) at age of Rapid River smallmouth bass, 2002-2004. Standard errors are in parentheses.**

Age	Length	Weight
0	2.2 (0.11)	*
I	3.4 (0.1)	0.03 (0.01)
II	6.5 (0.02)	0.1 (0)
III	7.6 (0.2)	0.2 (0.01)
IV	9.8 (0.7)	0.4 (0.1)
V	*	*
≥VI	13.3 (0.9)	1.2 (0.1)

---

**Table 20. Mean length (inches) and weight (lbs) at age of Pond in the River smallmouth bass, 2003 and 2004. Standard errors are in parentheses.**

Age	Length	Weight
0	1.9 (0.04)	*
I	4.8 (0.2)	0.06 (0.02)
II	6.2 (0.2)	0.1 (0.02)
III	9.8 (0.2)	0.5 (0.03)
IV	10.4 (0.1)	0.6 (0.02)
V	10.5 (0)	0.5 (0)

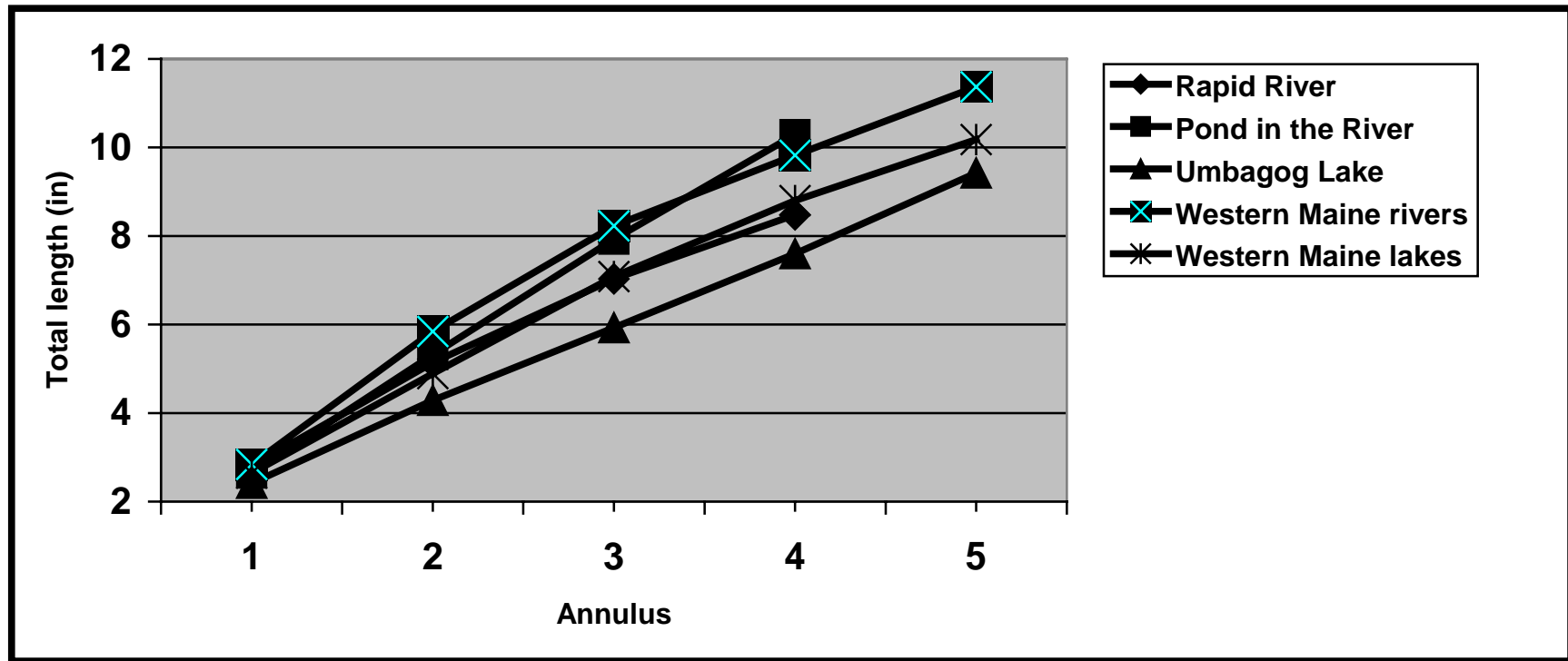
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**Table 21. Mean length (inches) and weight (lbs) at age of Umbagog Lake smallmouth bass, 2003-2004. Standard errors are in parentheses.**

Age	Length	Weight
II	5.5 (0.1)	0.06 (0.02)
III	6.7 (0.2)	0.1 (0.01)
IV	8.0 (0.3)	0.2 (0.05)
V	9.4 (0.2)	0.3 (0.03)
≥VI	12.0 (0.5)	0.6 (0.08)

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Figure 5. Backcalculated total length at age of smallmouth bass from several western Maine riverine and lake populations.<sup>7</sup>



<sup>7</sup> Rivers included the Androscoggin River (Gilead to Jay), the Kennebec River (Solon to Norridgewock), and the Sandy River (Phillips to Starks). Lake data from 17 waters, but predominately from Roxbury (Ellis) Pond, Mount Blue Pond, and Embden Pond.

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**Appendix 1. Summary of field notes made by MDIFW and FPLE biological staff, Rapid River and Pond in the River (PIR), 2003.**

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**May 29:** Recently emerged salmonid fry were observed at several locations below Lower Dam and at Wingate. Fish were in small groups in very shallow (<1ft) water in quiescent flow. FPLE staff collected 9 fry from Forest Lodge, Long Pool, and Wingate. Field ID was not possible; samples delivered to Danner for ID. Danner reported all were brook trout (BKT) based on a variety of external characters, including maxilla size and chin pigmentation. Danner not altogether confident of ID.

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**June 3 and 4:** Salmonid fry collected from several locations. Field ID's were still problematic. Samples sent to Danner who noted the difficulty of making positive visual ID because meristic characters of BKT and LLS overlap at this size. Danner compared pectoral fin/total length ratios with hatchery BKT and salmon (LLS) of same age and concluded that this ratio is the most accurate means of identifying each. Reexamination of 5/29 sample resulted in one fish being ID's as a LLS (8 BKT-1 LLS for that date).

**Middle Dam tailrace:** Fry moderately abundant on fringes of north shore. One smallmouth bass (SMB) captured.

**Wingate:** Fry moderately abundant on fringes from PIR upstream to first pool. SMB were abundant and easily collected, occupying same habitat as salmonid fry.

**Lower Dam (above, north shore):** Just a few fry collected on fringe in <1 ft water – cover marginal. SMB (I+?) were relatively abundant and occupying same habitat as salmonid fry.

**Lower Dam (below, north shore adjacent to spawning area):** Fry more abundant here than any area yet sampled. Good cover. Fry congregated in groups and somewhat smaller than from downstream reaches (LLS?). One SMB (I+?) collected.

**Wing Dam side channel:** FPLE electrofished entire channel to where it rejoins main flow near Aldro's. Fry were very abundant throughout.

**Aldro's:** Fry abundant on fringe of large pool in low flow areas. Fry very small.

**Long Pool:** Fry collected on north shore upstream and downstream of pool in pockets of low flow (0.5-1.5 ft depth). Flows were increased from 200 to 382 cfs since 5/29. This appears to have raised water level in river by 1-1.5 ft.

**Cold Spring Pool:** A few fry (<15) collected downstream of pool on north shore. Not as much low-flow habitat among boulders as at Long Pool – steeper and flow cascades through littoral habitat.

**Smooth Ledge:** Fry were easily collected below pool on north shore to about 100 ft below at head of side channel. Good fry habitat at 382 flow. Good flow and attractive juvenile habitat in

upper reach of side channel. SMBs (I+) were relatively abundant and occupying same habitat as salmonid fry.

Hedgehog Pool: No salmonid fry collected. One young SMB collected.

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**June 11:** Flows increased to 482 cfs. Flow velocities were noticeably higher in fry habitat. Fry collections made at Lower Dam and Long Pool. Large groups of fry observed very close to shore in lowest flow areas. Many more smaller individuals noted – these seemed more abundant in quicker water than did the larger fry (LLS?). Field ID's becoming more straightforward. Larger BKT fry beginning to show distinctive fin coloration. Samples of questionable fry sent to Danner.

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**June 17 and 18:** Flows reduced to 382 cfs. Fry occupying similar habitat to previous dates (shallow channel margins in quiescent flow). Field ID's still problematic for bulk of sample but getting easier. Some sent to Danner for positive ID based on pectoral fin length/total length model. More BKT taking on characteristic body shape and fin pigmentation by this date, and pectoral fin disparities becoming much more apparent. Boucher achieved 96% agreement between model and visual ID in lab.

Wingate: Salmonid fry easily collected, as were SMBs.

Lower Dam (above, north shore): Salmonid fry collected, but not as easily. No SMBs.

Lower Dam (below, north shore adjacent to spawning area): Salmonid fry very abundant in area adjacent to spawning area. No SMBs.

Wing Dam: Fry very abundant in side channel. Small brook/spring flowing at head of channel.

Long Pool: Fry moderately abundant. One juvenile SMB collected. Four SMB nests with incubating eggs observed in upper section of pool. One captured with e-fisher and radio tagged.

Cold Spring Pool: A small number of fry collected on fringes both upstream and downstream of pool.

Smooth Ledge: No salmonid fry or young bass captured. Two SMB nests with incubating eggs located adjacent to island. One shocked and radio tagged.

Cedar Stump: SMB black fry observed along north shore near campsites, some still associated with nests.

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**July 2:** Flows increased to 932 cfs, and river temps reached or exceeded 20°C for the first time. Salmonid fry collected from several locations. BKT and LLS fry were easily identifiable by this date.

Middle Dam tailrace: No salmonids collected along south shore (previous sampling conducted on north shore).

Wingate: Only one BKT fry collected.

Lower Dam (above, north shore): No salmonids collected, but young SMBs (I+?) were very abundant. One bass with YOY BKT in stomach. Bass tapeworm adults observed in gut. Black fry were abundant throughout in shallow rubble/boulder habitat.

Lower Dam (below, north shore adjacent to spawning area): BKT fry still easily collected along fringes, despite 22°C temp. LLS fry less abundant in same areas. One SMB collected.

Sugar Shack: Sampled at mouth of small trickle brook adjacent to Ray's camp. 16°C at river confluence. BKT fry easily captured at confluence and in brook, but most captured upstream to next camp, tight to shoreline. Low riparian vegetation throughout this reach – sensitive ferns, etc. – suggestive of ground water influence, but temperatures were 22° throughout the upstream sampling site.

Long Pool: BKT fry collected but with more difficulty – ditto for LLS. Two adult SMBs submitted by angler were both spent males (202, 295mm).

Cold Spring Pool: Significant spring located upstream of pool on north shore (per Aldro). Cool water (14°C) seeping through cracks in boulder/ledge substrate. *Fontinalis* moss in crevices. Several YOY BKT confined to the spring confluence. No LLS or SMB captured near spring or from downstream sample sites.

Smooth Ledge: Only two BKT fry and a single SMB (85mm) collected.

Devil's Hopyard (Car Pool): Investigated Aldro's report of spring area downstream of path accessing this pool (actually a deep run). Clouds of recently emerged black fry observed in fairly strong current at 2-3 ft depth.

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**July 16**: Temperatures declined slightly (1-2°C) and flows reduced to 800 cfs. Sampling effort now beginning to focus on BKT fry temperature refuges.

Middle Dam tailrace: Two BKT fry collected along north shore, both tight to shore in heavy rubble cover. Temperature was about 1°C cooler where BKT held compared to main flow.

Wingate: No salmonid fry collected. One SMB.

Lower Dam (below, north shore adjacent to spawning area): A few BKT still present (2-3 missed by netter). All very close to shore in quiescent flow. LLS fry now very abundant in quick shallow (<1ft) water – netters missed many.

Wing Dam: Large concentration of BKT fry located in cold seep at head of Wing Dam side channel. LLS very abundant in main flow at head of Wing Dam – missed many.

Sugar Shack: Small brook 14°C; @ river confluence 18°C; main flow 20°C. BKT fry easily captured both upstream and downstream of brook confluence.

Long Pool: Sampled upper site only. Both BKT and LLS fry increasingly difficult to collect.

Cold Spring Pool: Spring 6.5°C; 19°C below spring confluence; main flow 20.5°C. BKT fry not abundant this date.

Smooth Ledge: No fish of any kind collected.

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**July 31:** Work continuing to focus primarily on locating BKT fry temperature refuges, including those in PIR.

Middle Dam tailrace: Only one BKT collected.

Lower Dam (below, north shore adjacent to spawning area): No BKT collected. LLS still abundant in quick water in main flow.

Wing Dam: Spring seep 17°C; downstream of seep in fringe 19°C; 22°C in main flow. BKT fry still concentrated in pool @ seep, which is now isolated from river flow. Smaller numbers of BKT fry sampled below spring confluence tight to shoreline, and also on north shore of island along fringe. LLS fry still very abundant in main channel, shallow gravel riffles and runs.

Aldro's: LLS fry easily captured in slower current near Forest Lodge. SMBs also collected (116-134mm). One bass with YOY bass in gut.

Sugar Shack: BKT fry still present in areas described above, and LLS fry becoming increasingly abundant in same area.

Cold Spring Pool: Spring 6°C; main flow 21°C. Only two BKT fry collected. Spring influence seemed less than previous dates.

Devil's Hopyard (Car Pool): Spring seep below access trail 13°C; main flow 21°C. YOY bass most abundant here (29-45mm); one BKT fry collected.

Pond in the River: Located only one spring seep west of Lakewood docks near mouth of small trib (17°C – lake 24°C). About 6-8 YOY trout collected here. YOY and yearling (?) SMB extremely abundant throughout littoral zone from docks and west to well beyond seep. No other seeps located in PIR (see map in files).

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**September 10 and 11:** Sampling focused on evaluation of BKT temperature refuges identified earlier. Lower Dam (above), Long Pool, and Smooth Ledge were also re-examined to assess salmonid fry use with declining river temperatures. Fin tissue samples obtained from BKT fry for genetics analysis.

Lower Dam (above, north shore): Sampled a small area along fringe. No salmonids; 2 SMBs.

Lower Dam (below, north shore adjacent to spawning area): No BKT captured in fringe habitat. LLS fry still abundant in faster flow – missed several. Also captured YOY SMB's.

Wing Dam: Spring seep 12°C; river 19°C. Sampled @ spring seep and below along south shore of side channel. BKT fry still congregated in spring – none captured along fringe of side channel. LLS and SMBs now occupying fringe habitat where BKT fry previously collected. LLS fry still very abundant in main flow.

Aldro's: Only one each of BKT and LLS captured in short reach below Forest Lodge. BKT appeared to be a recapture from previous day's sample @ Wing Dam spring seep.

Sugar Shack: Small brook 10°C; river 19°C. Only one BKT collected. LLS and SMB fry now occupying fringe habitat previously utilized by BKT.

Long Pool: Sampled in boulder/rubble fringes above and below pool, north side. Only one each of BKT and LLS captured. SMB YOY present in this same habitat.

Cold Spring Pool: Spring 7°C; river 18.5°C. Sampled at spring, in shallow pocket water just upstream of spring, and on fringe downstream of pool. One BKT and one LLS fry collected.

Smooth Ledge: No salmonids collected (missed one LLS). SMB fry present in fringe habitat.

Devil's Hopyard (Car Pool): Spring seep 16.5°C; river 18°C. No salmonids collected. SMB fry collected in fringe habitat.

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**October 2 and 3:** 500 cfs and 16°C. Efforts directed at completing genetics sampling, evaluating efficacy of beach seine to collect BKT brood, and examining BKT spawning site located fall 2002 (below Lower Dam). Genetics sampling focused primarily on area immediately upstream and downstream of Lower Dam and at Wingate.

Adult and juvenile trout captured at all locations, as were LLS, which appeared to be at least as abundant as BKT at most sites. In "spawning trough", divers observed 8-12 adult BKT – no other species present. Males were very aggressive and territorial; females were less active but were clearly approaching spawning condition as evidenced by their presence over suitable spawning substrate and very distended ovipositors.

Principal BKT spawning site characterized by mounds of gravel interspersed among scattered large boulders and woody debris. Strong flow over and through substrate, which was deep (in excess of 1') and un-embedded. Gravels ranged in size from about ¼" to 3" in diameter.

Divers also observed smaller congregations of BKT just upstream of Lower Dam and in the Wing Dam area.

Beach seine proved to be completely unworkable at spawning trough. It may be possible to use trapnets at gravel bar just upstream of spawning site adjacent to large back-eddy, and upstream of Lower Dam.

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**October 21:** FPLE staff observed several BKT spawning upstream of the Lower Dam sill area. BKT were utilizing the same areas as observed in 2002. Several BKT observed spawning in the "trough" area in gravels ranging in size from ¼" to 3" in diameter. All trout redds were in water depths ranging from 4 to 6 feet of water. BKT were utilizing the same area with the same intensity as observed in 2002.

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**November 6:** FPLE staff observed spawning activity on south side of the island at Wingate (inlet to PIR). Redds (2-4) were located mid-channel in approximately 1-2 feet of water. Egg size indicated LLS. Several LLS redds located upstream of Lower Dam and along the sill of the existing dam structure. Impossible to count number of redds due to the superimposition of excavations.

In spawning trough below Lower Dam, several LLS observed digging in the same area that BKT utilized on 10-21-03. Divers noted that LLS were digging less defined redds and they were moving large amounts of material. Impossible to count number of redds due to the superimposition of excavations. Divers noted that the area had been almost entirely reworked since the BKT survey. There were still a few BKT remaining in the area mixed in with the LLS. All redds were located in water depths ranging from 3-6 feet. Underwater video was taken of these spawning fish.

Divers and snorkelers noted that substrate on the upstream side of the island was being excavated by LLS. No digging was observed in this area at the time of the BKT survey. All redds were located in water depths ranging from 1 to 3 feet. Observations and underwater video were taken of these spawning fish.

FPLE biologists observed a few LLS utilizing the Wing Dam area this date. Redds revealed a few BKT eggs but LLS eggs were more numerous. These redds were in water depths ranging from 1 to 3 feet.

At the head of Long Pool 6-8 pockets of gravel appeared to have been worked. Investigation revealed no eggs and it was determined that these were probably test pits. No fish or additional spawning activity was observed in the Long Pool area during the survey.

**December 12:** Flows very high (1,900 cfs). Telemetry work conducted between Middle Dam and Lower Dam. One salmon moved to Middle Dam and apparently succumbed to mink/otter predation. Mortality signals being received from several other LLS, but uncertain if fish simply weren't sufficiently active to trip signal out of "mortality mode". Many fish (with and without mortality signal) have moved into PIR. Flight scheduled prior to Christmas.

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